POWER

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Intention and Accomplishment

MANY young men, of the graduating age, have an exaggerated idea of their own qualifications and abilities and a patronizing tolerance for the shortcomings of their elders.

Their newly developed reasoning faculties, a sense of their modernity and greater advantages and particularly the fact that their self esteem is based upon the things that they are going to do, while their estimation of their forbears rests upon the actual accomplishments of the latter, are probably responsible for this state of mind.

As they get on they will appreciate the difference between ideals and attainments, between intention and accomplished fact.

It is the things that one has done, not the things that one is going to do, or thinks that one could do that constitute one's service to the world and set the measure of one's success.

Some men have the faculty of getting things done. They put their ideas or those of their employers into execution. Things about them are constantly improving and the possibilities of their environment and condition are worked out.

If they are engineers their plants are trim, tight and efficient, their records complete and well kept, and their ideas for the improvement of their equipment, mental and physical, are materialized so far as their resources and ingenuity will permit and avail.

Others live in a fool's paradise of unrealized ideals. They see things not as they are, but as they intend or hope to have them, but without any compelling effort to make them so.

But the life that they lead, the things that they have, the way that they have them, and the pace that they make on their way through life depend not upon their dreams, but upon what they see through to a finish.

Hell is paved with good intentions.

F. R. Low

Modernized Boiler Plant and Electric Drive Nets 35 per Cent on Investment

BY H. M. WILSON
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BY REPLACING obsolete engine and power transmission equipment with motors using purchased energy, and by substituting stoker-firing with redesigned furnaces for hand-firing, the management of a textile mill, with an initial investment of $225,000, reduced the annual operating cost from $195,000 to $115,000.

HARRY FAY, chief engineer of the plant of John Bromley & Sons, Inc., Philadelphia, was operating three hand-fired boiler rooms, and providing power at various points by means of belt, rope and electrically driven equipment. He became convinced that the plant was far behind the operating accomplishments that should be attained. The plant was a large power user at all times, while the uses for exhaust steam in the summer were comparatively few. To secure anything like an efficient operating plant, motor-driven equipment was imperative. This meant either the installation of complete generating equipment or the purchase of power.

To find the best solution, he advised the management that engineers be engaged to go over the plant, secure costs and submit a report. From the data obtained it was evident that motorizing was of prime importance and that in this case it was more economical to purchase than to generate energy. The carrying charges and space requirements plus the inability to use the exhaust steam at all times, made the central-station proposal attractive. The figures compiled showed that the centralizing of the boiler plants and the operating of this plant by modern methods would result in additional and even greater savings. The existing steam generating units were separated into three plants: The lace mill, where two 2,500-sq.ft. water-tube boilers were installed; the Gurney Street mill, operating five 1,250-sq.ft. horizontal return-tubular units; and the main mill, which consisted of five 4,000-sq.ft. water-tube boilers.

Power had been supplied by several large engine-driven generators, together with a number of smaller vertical engines which drove lace machines, tenters, dye-house equipment, etc. The largest generating unit was a 700-hp. twin Corliss engine, which operated a part of the plant by means of rope drive, and at the same time had connected to it by means of secondary roping, a 312-kva. generator. In the lace mill a 200-kw. direct-current machine was operated by a Corliss engine. This machine was used to supply most of the direct current utilized around the mill. The picker house, which was the other large user of power, was driven by belts connected directly to a 125-hp. Westinghouse vertical engine. In addition to the foregoing, there was a 100-hp. Westinghouse engine driving a direct-current generator. The engine output of the entire mill exceeded 1,200 hp., the friction load perhaps representing as high as 30 to 35 per cent of the power consumed.

The various engines, etc., were replaced by motors;

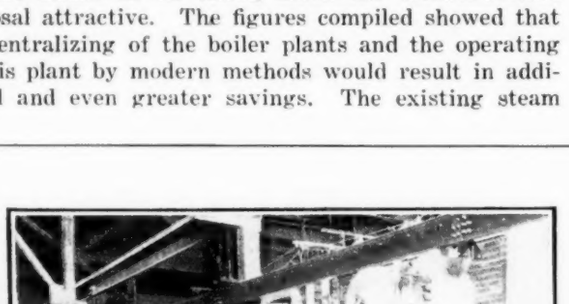

Fig. 1—Boiler room before rebuilding

This floor had to be lowered 18 in. and space provided underneath for vacuum ash conveyors and forced-draft ducts

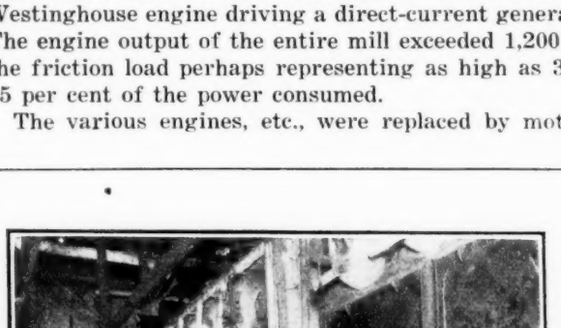

Fig. 2—Boiler room after rebuilding

Increased combustion space with stokers and new baffling make new boilers out of the old

in some cases machines were grouped, and in other places individual drives were provided. As speed variation was essential in a number of cases direct-current was retained in some parts of the mill, instead of completely motorizing the plant with alternating-current equipment. The direct-current is supplied by a synchronous motor-generator set, consisting of a 225-hp.

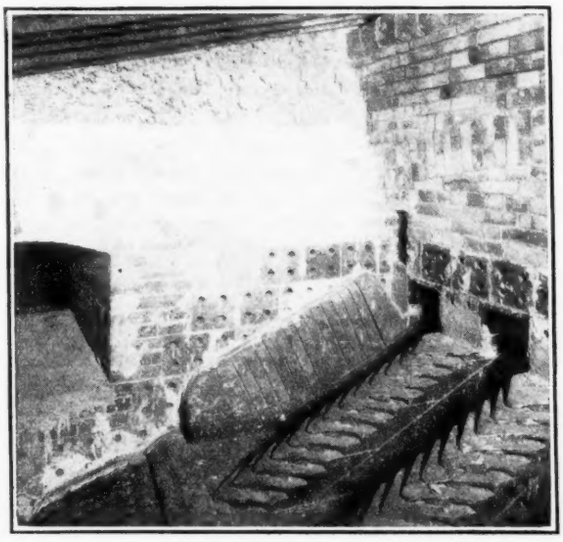

Fig. 3—Underfeed stokers chosen to meet sudden fluctuations in steam demand

alternating-current motor, driving a 150-kw. direct-current generator. As only a small quantity of direct-current is needed, the equipment is used primarily for power-factor correction, which is essential. To correct the power factor further, there is also installed a 75-hp. synchronous motor with field control.

The transformers which reduce the voltage from 13,200 to 440 volts, consist of three 333-kva. units for power requirements, the lighting being carried from three separate 75-kva. transformers. Smaller transformers are used over week ends or shutdown periods, when it is not essential that the large transformers be in service.

Five Boilers Retained and Arranged for Stoker Firing

The maximum boiler load was found to approximate 100,000 lb. of steam per hour. Even with the mill electrified, in winter the plant might at times be called upon to produce this capacity. After a careful check of the present conditions it was decided that the five 4,000-sq.ft. water-tube boilers in the main boiler room, if equipped with stokers, were of ample capacity and size, and that four could carry the load with one held at all times as spare.

These boilers had been installed in 1916 and were in good condition. The boiler plant was in a four-story building, and lack of headroom made the raising of the boilers for the installation of stokers out of the question. It was therefore decided to underpin each of the units and prepare space below the present operating floor for the ash conveyor, air ducts, etc. The present operating floor is 18 in. below the former floor line to provide increased furnace volume. Special supports had to be provided for slinging the boilers in place, so that there would be no undue strain or settlement. All the excavation was accomplished and the footings carried down to a depth of 10 ft. without mishap.

With the electric load discontinued, the boilers are called upon to carry great fluctuations in steam demands. This is especially true when the dyehouse and washhouse are operating at anything like capacity. The boilers at one time may be operating at 200 per cent of rating and over, with the demand falling off within a few minutes to less than 25 per cent of this capacity.

It was believed that the ability to maintain steam readily and meet the sudden demands of fluctuating loads, could be successfully met by an underfeed type of stoker, and it was decided to install Taylor stokers which are driven by variable-speed alternating-current motors, through a planetary transmission which provides two speeds and a neutral position with all gears constantly in mesh. An auxiliary steam drive is also provided.

Air for the stokers is supplied by three motor-operated fans, one having a dual steam and electric drive. Two of the fans are capable of delivering sufficient air for the maximum output, which gives one reserve unit.

Each of the individual air ducts is controlled by means of a separate damper. The louver dampers on the fans themselves are controlled by means of damper regulators which operate from the steam pressure of the boilers.

Aside from the stokers the problem to be met was the method of coal handling and ash removal. To facilitate getting the coal into the boiler room, a hopper

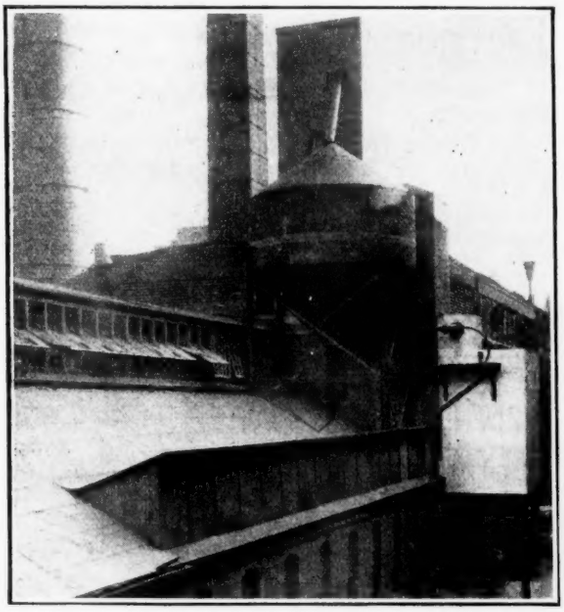

Fig. 4—100-ton iron coal storage tank and 30-ton concrete ash storage tank

was constructed in the yard, and coal carried from this hopper through a crusher and elevated vertically by means of a bucket elevator. This elevator deposited the coal in a 100-ton storage tank. Owing to the building conditions, this coal tank had to be located outside the boiler room proper and the coal spouted from it to the weigh larries. This equipment has a capacity of 25 tons an hour.

The ashes fall into an ash aisle underneath the boiler-

room floor and are discharged by a vacuum ash conveyor to a 30-ton concrete storage tank adjacent to the boiler room. The vacuum is produced by a steam jet. A vent from the tank is carried directly to the stack, so that the dust, etc., is negligible.

In the new furnaces air-cooled front and side walls are used. With these walls the trouble formerly experienced from clinkers adhering to the side walls, has been eliminated, and the walls of the first unit, placed in operation nearly two years ago, show no signs of deterioration.

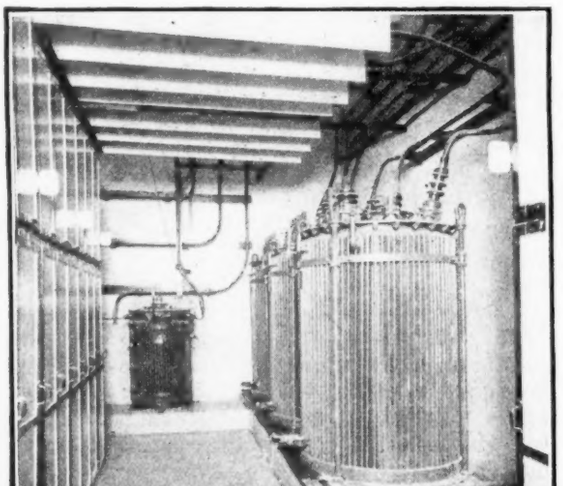

Fig. 5—Voltage stepped down from 13,200 to 440 volts for use in the plant

All the boilers have the bridge-walls battered to reflect heat into the tubes, and the old baffles have been replaced by inclined monolithic baffles. Table I is taken from a test covering three of the boilers.

TABLE I—TEST PERFORMANCE OF REBUILT 4,000-SQ.FT. BOILERS

Proximate Analysis of Coal:		Per Cent
Moisture		2.74
Volatile matter		16.05
Fixed carbon		74.98
Ash		6.23
		100.00
Average Rating Developed	Day Per Cent	Night Per Cent
Boiler No. 1	172.5	73.0
Boiler No. 2	166.5	82.8
Boiler No. 3	135.0	80.3
Results of Tests:		
Water evaporated per pound of dry coal—		Lb.
Boiler No. 1		10.16
Boiler No. 2		10.22
Boiler No. 3		9.65
Average equivalent evaporated per lb. dry coal, lb.		11.12
Average efficiency of boilers, per cent		73.0
Approved boiler pressure		90 to 100 lb.
Pressure in dyeing plant		90 to 100 lb.
Pressure on driers		10 to 15 lb.

The steam output of the boilers is recorded upon flow meters of the integrating, recording and indicating type. To check the entire plant for boiler-feed makeup, a meter is installed on the water-softening units. The flue-gas temperature of each boiler is recorded at all times upon recording thermometers, located on a gage board on which the boiler draft gage and the flow meters are also mounted.

All the returns from the heating system, driers, etc., are delivered back to an open feed-water heater, thence pumped to the boilers. Makeup water for the plant is provided by two water-softening units having a capacity of 150,000 gal. each. The water-softening equipment was installed with a view of providing soft water for the dye and wash houses, in addition to the boiler plant. Since the installation of this equipment there has been no trouble experienced with the boiler tubes, although ratings of 250 per cent have been carried for a period of four hours at a time.

Annual Saving of $80,000 Exceeds Estimate

The coal formerly burned amounted to more than 20,000 tons annually. Not only was this reduced to less than 10,000 tons annually by the new arrangement, but also a cheaper grade of fuel can be used. Only part of this coal saving should be credited to the changed boiler plant, however, the rest being due to motorizing the plant.

The entire cost of the installation, including motorizing, installation of the transformers, the equipping of the boilers with modern stokers, coal conveying, etc., represented an expenditure of approximately $225,000. Table II gives the annual costs before and after the changes were made, together with estimated annual costs. It is seen that approximately $80,000 a year was saved by the investment.

TABLE II—COMPARISON OF ANNUAL COSTS IN 1923 WITH ESTIMATED ANNUAL COSTS AND WITH ANNUAL COSTS IN 1925 AFTER CHANGES HAD BEEN COMPLETED

	Year 1923 Old Plant		Estimated Plant Motorized Only		Estimated Plant Motorized and New Boiler Equipment		Year 1925 New Plant
	No.	Annual Cost	No.	Annual Cost	No.	Annual Cost	Annual Cost
Coal*	..	$145,936	..	$117,900	..	$78,720	$64,602
Ash removal	..	9,215	..	7,400	..	3,500	1,211
Engineers†	4	9,000	2	4,500	2	4,500	4,522
Water tenders†	3	6,600	3	6,600	3	6,600	18,469
Firemen	7	12,300	5	9,350	3	5,600	
Helpers†	6	9,360	6	9,360	4	7,240	
Upkeep	..	2,500	..	2,500	..	5,000	3,120
Electrical charge	..	.....	..	27,000	..	27,000	22,853
Total		$194,911		$184,610		$138,160	$114,777

* Coal consumption, 1923, 20,405 tons; estimated with motorized plant, 16,400 tons; estimated with motorized plant and new boiler equipment, 13,120 tons; and 1925 actual consumption 9,280 tons.

†Rates of pay as follows: Engineers, $2,250 a year; water tenders, 65c. an hour; firemen, 50 and 60c. an hour and helpers, 50c. an hour.

In the Planning of a Layout, templets are a great aid in securing the best arrangement. Paper patterns are cut out and shifted about on the floor plan until the superintendent and foreman are both satisfied. This is vastly better than leaving it to the draughtsman, for even a corrected drawing seldom gives the best possible results. In fact, it takes less time to work with templet patterns than it does to draw in two or three trial arrangements. The suggestions of those who are especially familiar with the kind of work in question are always well worth while.—*F. H. Randolph.*

R. J. S. Pigott, author of the description of the Kearny Station, published in *Power* for Aug. 31, 1926, has called attention to the omission of the name of the Smoot Engineering Co., which furnished the regulators that control the generator air duct automatic doors furnished by the Carrier Engineering Co.

A Direct-Current House Generator is not assembled on the main turbine generator shaft in a steam power plant because of the difficulty of maintaining good commutation at the speed of the main unit.

Testing a Surface Condenser in Action

By CHARLES E. COLBORN
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How often should a condenser be cleaned? Does it need cleaning tonight, or can it run until next Saturday? Is it getting enough water? Is the air pump working well? These and similar vital questions can be answered only by testing frequently and carefully

WITH the continual increase in size of the larger surface condensers and the growing tendency to keep consistent check of all surface-condenser performances, field testing has become an important part of their operation.

Although condensers up to 10,000 sq.ft. of surface may usually be shipped assembled, the larger units must of necessity be assembled and tested in the field and those of even smaller size can seldom be shop tested owing to the lack of facilities for properly handling the steam required and the condensate produced.

In few instances are condensers purchased without definite warranties as to performance under existing conditions of load, etc., and it is imperative in all cases for a fair fulfillment of the contract that field tests should be made to determine the performance. To secure the maximum performance, a continuous check is necessary, not only to detect unusual conditions such as air leaks, but to assist in forecasting the probable need for cleaning of the condenser tubes.

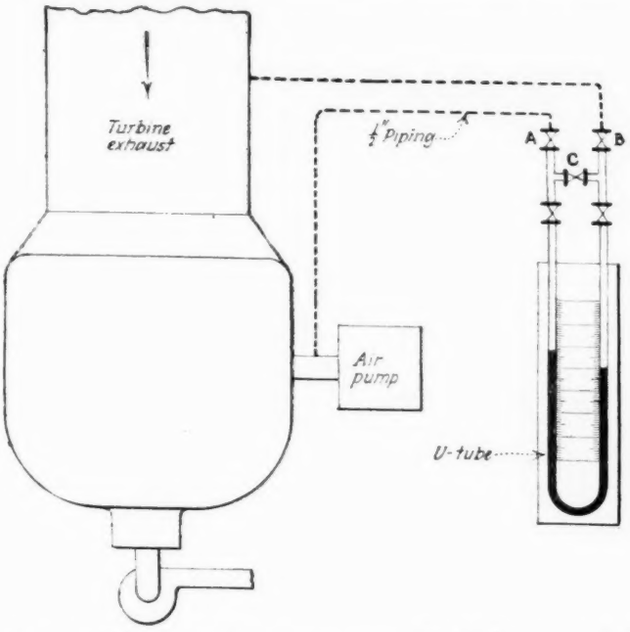

Fig. 1—Differential pressure gage should be connected with a crossover valve C

In previous articles in *Power* the author has described methods of cleaning tubes and the results secured, and has explained the method of calculating the cleaning periods if the maximum financial benefit is to be derived therefrom. The securing of the data needed for these processes is similar to that required for field tests, excepting in the matter of accuracy of data secured. Data taken on acceptance tests should be as complete as possible and as accurate as is consistent with the use of good engineering judgment.

The extent of these data is governed largely by the nature of the manufacturer's warranties. Specimen guaranties as made by one manufacturer on a 27,000-sq.ft. unit are given in the accompanying table.

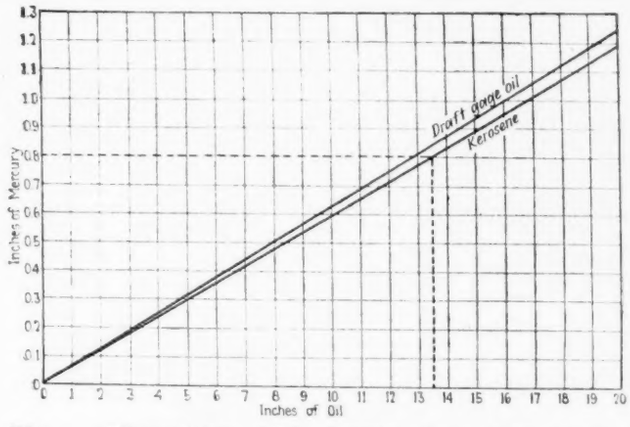

Fig. 2—Oil readings to the nearest $\frac{1}{16}$ in. give pressure differences to 0.01 in. of mercury

The extent of these guaranties indicates at once the test data required to substantiate them. It is necessary to have a measure of the load on the condenser, the inlet-water temperature through the condenser, the exhaust-steam and hotwell temperatures and the vacuum at the condenser inlet. Besides these, data are required on the circulator performance and the pressure or vacuum existing in the circulating water piping at the inlet to and outlet from the condenser. The securing of the vacuum drop across the condenser requires especial care and should never be neglected, since in this performance factor alone lies a large potential loss. If the condenser has a drop in vacuum from the air-pump suction to the condenser inlet of one-half inch of mercury at full load, a comparatively large monetary loss is incurred.

For example, in the condenser whose guaranties are quoted in the table, a drop of one-half inch in vacuum through the condenser would require the circulation of 60,000 gal. per min. of circulating water to obtain the 1-in. guarantee in addition to the installation of air ejectors capable of handling the normal air leakage at

0.5-in. pressure. This expense would be such as to make the attainment of the maker's warranties practically impossible.

This drop is measured from the suction pipe of the air removal apparatus to the condenser inlet exhaust neck. To obtain this measurement accurately, a U-tube is used, connected as shown in the sketch Fig. 1, and graduated to read directly in inches. The equalizer piping arrangement shown greatly simplifies the obtaining of these measurements. The measuring medium which has been successfully used is light mineral oil. The type commonly sold for draft gages is satisfactory, although in emergencies common kerosene may be used.

SPECIMEN GUARANTEE ON 27,000-SQ.FT. SURFACE CONDENSER

Condensing area	27,000 sq.ft.
Steam to condenser	173,000 lb. per hr.
Gal. per min. Circulating water	20,000
Temperature Inlet Circ. water	55.0 deg. F.
Absolute pressure at condenser inlet flange	1.00 in.
Temperature difference steam to condenser and hotwell condensate	1 deg. F.
Drop in vacuum from air ejector suction to condenser inlet flange	under 0.2 in. mercury
Hydraulic loss of head through condenser	6.0 ft. water

Fig. 2 gives curves for converting a reading in inches of oil or kerosene to the equivalent inches of mercury. In connection with the use of U-tubes for vacuum or pressure measurements, it is the author's belief that their accuracy is of the order of one-quarter inch; that is to say, that they cannot be read successfully under normal conditions and without especial care to within a quarter inch of the true reading. With this limit an accuracy of less than five one-hundredths of an inch of mercury is easily attainable. It is felt that this is considerably better than any other method available today for measuring such small pressure differences. Experiments on the effect of the exposure of the oil to vacuum on its specific gravity have shown that there is no change in the mercury equivalent values given on

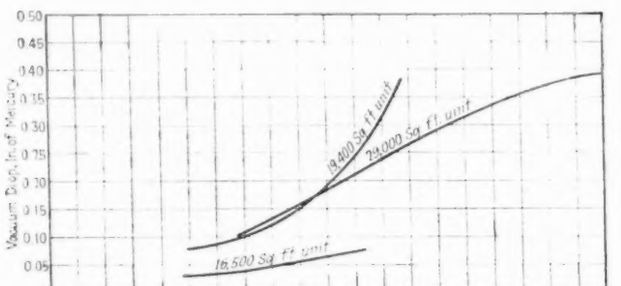

Fig. 3—Actual test curves from various condensers show marked differences

the curve for ordinary temperatures and all vacua in the surface condenser range.

In the use of this method no trouble will be experienced if the U-tube is connected up entirely as shown in the figures with the equalizer valve assembly in its connections. With valves *A* and *B* (Fig. 1) closed, open the crossover valve *C*, then open valve *A* slowly. When it is wide open, valve *B* should be slowly opened, after which the crossover valve *C* should be closed. About 10 minutes will be required for the oil to deaërate, after which measurements can be made. Deaëration of the oil can be expedited by causing the column to surge by opening and closing the crossover valve *C*.

In Fig. 3 are shown the drop in vacuum test characteristics of three condensers of different makes. It is evident that by proper design this factor can be kept small throughout a large range of loads and condenser sizes.

It has been the author's experience in the course of a considerable number of tests on surface condensers under a wide variety of operating and test conditions, that for the average run of performance determinations the steam to the condenser may be taken as the amount

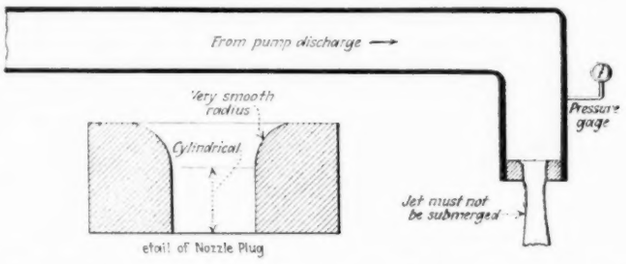

Fig. 4—An orifice provides an easy means of measuring water quantity

shown by the flow meters on the prime mover plus what leakage is known to exist in the condenser. In cases where no flow meter is available but where the condensate is discharged into a heater or other apparatus in such manner that the end of the pipe is not submerged, an orifice can be utilized measuring the flow to a degree of accuracy sufficient for condenser test calculations. This orifice, whose application is shown schematically in Fig. 4, may be machined from brass or iron, and a length of uniform cross-section equal in length to about three-eighths of the diameter of the orifice should be left as shown to insure smooth flow. It is also necessary that the entrance should be well rounded and smoothed.

A family of curves is given in Fig. 5 for use in measuring the flow of water through such orifices. These curves have been calculated for water at 70 deg. F., but are little affected by variations in temperature such as are met with in condenser work. Pressures at each side of the orifice should be read when possible in inches of mercury and the gage pressure mentioned on the curve determined by difference. The jet of water should discharge freely into the air and not become submerged under any condition of operation. Where conditions permit, measurements made in this manner will be found more satisfactory for acceptance tests than any other sort, short of weighed water tests, which are beyond the capacity of the majority of installations.

For taking temperature measurements it has been the practice to use ordinary glass chemical thermometers about 12 in. long, which will give excellent results for this service. For all but the most accurate work, thermometers graduated to one degree are satisfactory. Under no conditions should attempts be made to read such thermometers closer than to one-quarter of a degree, and then considerable judgment should be used in applying and interpreting the readings secured. Two excellent and easily made types of thermometer wells for these uses are shown in Fig. 6. The first well is turned from solid stock. The second is made by turning a suitable brass bushing and rolling or sweating into it a short piece of condenser tube or small-diameter brass pipe. The bottom of the tube should be crimped and soldered to prevent leakage. If the

wells are made of brass, oil or water should be used as a filler, due to the action of mercury on the brass. For accurate readings the thermometers should never be submerged less than half their length in the wells. A good kink which saves much breakage is to put a small

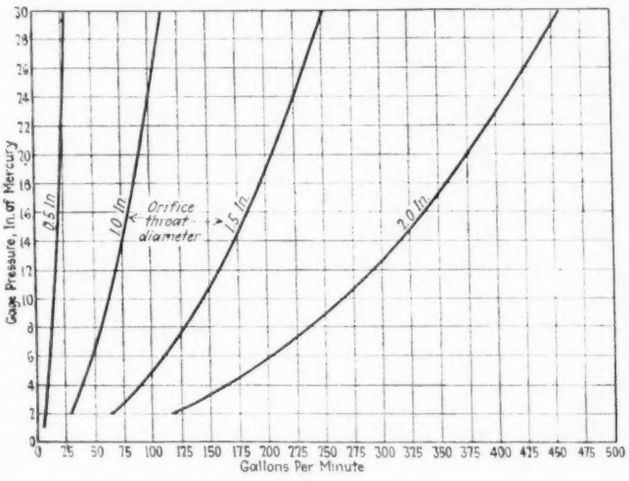

Fig. 5—Curves of discharge for well-rounded orifice not submerged

piece of paper or rag into the bottom of the well for the thermometer to cushion on.[1]

In making condenser tests, these wells should be provided for the inlet and outlet circulating-water temperatures as well as for the steam to the condenser and the hotwell. In all cases the wells should be installed in such a position as to be directly in the flow of the medium measured. Dead spaces and insides of bends should be particularly avoided. For use with steel pipes the wells should extend into the water not less than three inches and in the condenser shell should preferably extend through the shell by at least six inches. The hotwell thermometers will give more satisfactory results when inserted into the suction line to the hotwell pump rather than into the hotwell of the condenser itself. Care should be used not to get this well in such position that it is influenced by after-condenser or other drains into the hotwell, giving false readings. Measurement of the temperature of the air-vapor mixture in the suction pipe to the air-removal apparatus is so difficult that it is of little use to try to make any determinations of partial air pressures in this pipe by the temperature method.

Little can be done on circulating pump measurements without special preparation. The pump makers will usually furnish guarantee curves of the pump performance, and if the total head developed by the pump be determined, the approximate discharge can be found, or it may be computed from the heat balance.

$$(\textit{Heat absorbed by water}) = (\textit{Heat given up by steam})$$

$$(\textit{Lb. water per hr.}) \times (\textit{temp. rise}) = (\textit{lb. steam per hr.}) \times 950$$

The heat given up by one pound of steam in condensing is approximately 950 B.t.u. Hence

$$(\textit{Lb. water per hr.}) = \frac{(\textit{lb. steam per hr.}) \times 950}{(\textit{temp. rise of water})}$$

and since 1 gal. per min. is roughly equivalent to 500 lb. per hr., it follows that

$$(\textit{Gal. water per min.}) = \frac{(\textit{lb. steam per hr.}) \times 1.9}{(\textit{temp. rise of water})}$$

This result will be sufficiently accurate for ordinary condenser tests.

In making tests at various load conditions, it is the author's experience that after any load change a period of from five to fifteen minutes, depending upon the condenser size, should be allowed for the condenser to settle down. Also that much more consistent results will be obtained in a series of condenser tests if the higher loads are taken first, allowing the condenser to cool down as the lower loads come on. It has been his practice to take never less than five readings at any one load point, spacing these readings not less than three minutes apart, and averaging the whole set for the value taken for the point tested. By such methods good results have been obtained under unfavorable operating conditions and without the use of specially trained observers.

The necessary calculations for working up tests have appeared so often that the formulas only will be given:

$$\textit{Temperature rise of water, deg. F.,} = TR = (\textit{temp. entering}) - (\textit{temp. leaving})$$

$$\textit{Mean water temperature, deg. F.,} = MWT = [\textit{temp. entering}] + \frac{TR}{2}$$

$$\textit{Mean temperature difference, deg. F.,} = MTD = (\textit{temp. of exhaust steam}) - MWT$$

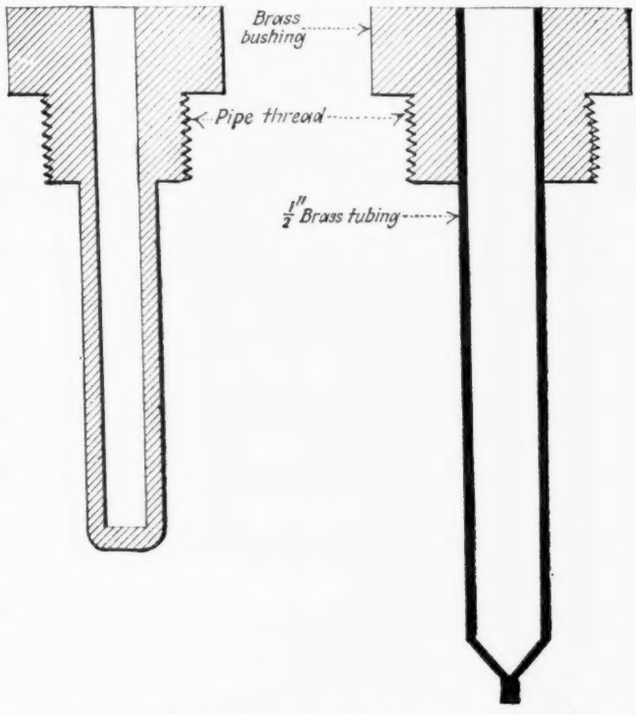

Fig. 6—Thermometer wells are easy to make

$$\textit{Heat transfer coefficient, B.t.u. per sq.ft., per deg. F., per hr.} = U = \frac{(\textit{lb. steam per hr.}) \times 950}{(\textit{surface in sq.ft.}) \times MTD}$$

In the use of such formulas engineering judgment is of great value. In the calculation and comparison of results of tests with the guarantees or with other test results, it is needful that considerable study of the tests and allowances for their exactness be made as only through such procedure can the real value of field tests on surface condensers be obtained.

[1] The reader is referred to the test codes of the A.S.M.E. for more detailed instructions for the measurement of temperature. Material not yet in final form has been published in *Mechanical Engineering*, or is available from the Society headquarters.

Starting Squirrel-Cage Type Induction Motors

Comparison of the Advantages and Disadvantages of the Compensator and the Resistance-Type Starting Equipment

By G. O. WILMS
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SQUIRREL-CAGE induction motors, when properly loaded, are ideal for general-purpose applications, because of their simplicity and reliability. The main objection to their general use is their comparatively low starting torque and large starting current. The first objection can be overcome by changing the rotor resistance, unfortunately, however, only with a sacrifice in efficiency. The second objection can be reduced by the use of an internal starting device, but this means a sacrifice in the simplicity of the motor.

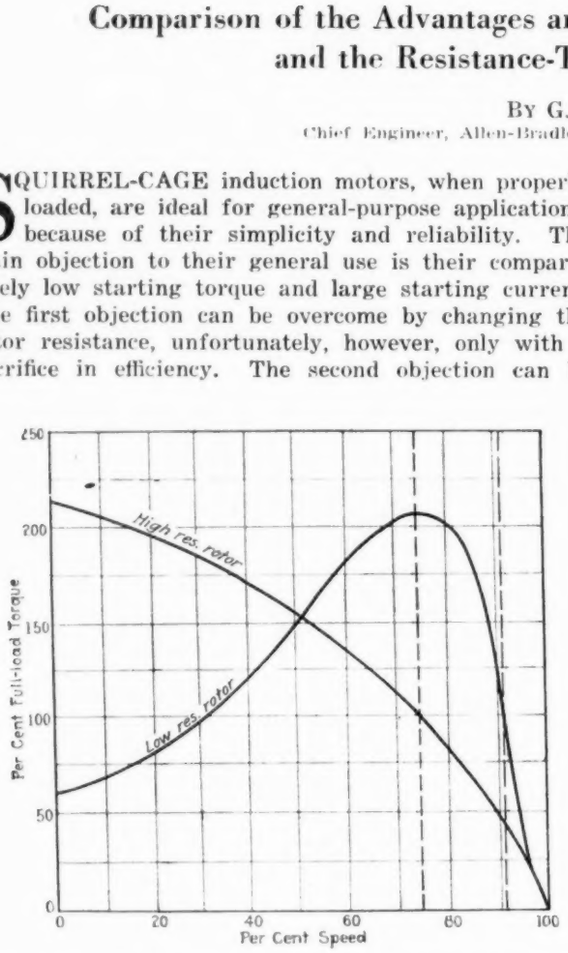


Fig. 1—Speed-torque curves for a high-resistance and a low-resistance rotor motor

The maximum torque that a given squirrel-cage motor can exert is independent of the rotor resistance, but the speed at which the motor develops its maximum torque depends on the rotor resistance, as shown in Fig. 1. The higher the rotor resistance the lower will be the speed at which the squirrel-cage motor develops its maximum torque. For example, in the figure the high-resistance rotor develops its maximum torque at standstill, whereas the maximum torque of the low-resistance rotor is developed at about 75 per cent speed. At about 92 per cent synchronous speed the low-resistance rotor produces 100 per cent, or full-load torque, where the high-resistance rotor operates at only about 75 per cent synchronous speed at full load.

From the foregoing, it is evident that, if the simplicity and high efficiency of the motor are to be retained, little can be done to improve the starting torque and reduce the large current inrush when starting a standard squirrel-cage motor. There are in use at the present time three distinct methods of starting squirrel-cage motors: (1) By throwing them directly on the line; (2) by means of a primary-resistance starter; (3) by means of an auto-starter or compensator.

The star-delta method can be regarded as a special case of the compensator method.

The three curves in Fig. 2 show the relation of speed to torque, obtained with these three methods. Since the torque of a squirrel-cage motor at any given speed is approximately proportional to the square of the applied voltage, the across-the-line starting will provide the greatest torque and is represented in curve *A*. Curve *B* shows the conditions for the primary-resist-

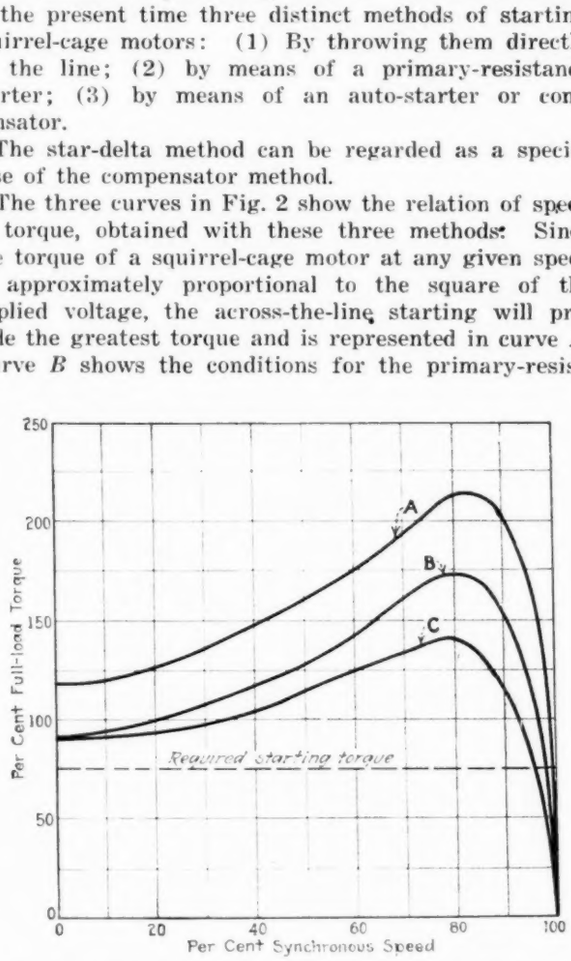


Fig. 2—Curves showing the torque developed by a motor when started by three different methods

Curve *A* torque developed when motor is connected directly across the line; curve *B*, starting with compensator; curve *C*, starting with resistance in series with stator winding.

ance type starter, and curve *C* for the compensator type of starting. For methods *B* and *C* the same initial starting torque has been assumed.

From the three curves, Fig. 2, it can easily be seen that across-the-line starting provides the largest torque and quickest acceleration to the motor. For resistance-type starting the maximum torque is less and it is lowest for compensator starting. Assuming the same initial starting torque, it takes the longest to bring the motor up to full speed with a compensator. The reason is that the starting voltage remains the same

up to the point where the motor is connected to full voltage, whereas with a resistance starter the voltage across the motor will increase as the current decreases.

Assume starting on a 220-volt circuit with a resistance-type starter, where the initial starting current is 60 amperes and the resistance of the starter one ohm. The voltage drop across the starting resistance will be $1 \times 60 = 60$, leaving $220 - 60 = 160$ volts at the motor terminals. If, as the motor comes up to speed, the current decreases to 30 amperes, the voltage drop across the starting resistance will decrease to $1 \times 30 = 30$, and the voltage at the motor terminals will increase to $220 - 30 = 190$ volts. In this case, when the motor is connected to full voltage it will be operating at a speed corresponding to 190 volts. Another feature is that the motor will be connected to the line by short-circuiting the resistance, so that the actual voltage change at the motor terminals is from 190 to 220 or 30 volts.

Starting with a compensator on a 75 per cent voltage tap will give about the same initial starting voltage at the motor terminals as did the resistance starter. In the case of the compensator, however, the starting voltage will remain constant, being fixed by the ratio of the auto-transformers, so that when the motor is connected to full voltage it will be operating at a speed corresponding to about 160 volts instead of 190. Furthermore, the motor is disconnected from the line before it is thrown to full voltage. Therefore, under the best conditions the line voltage at the motor terminals would

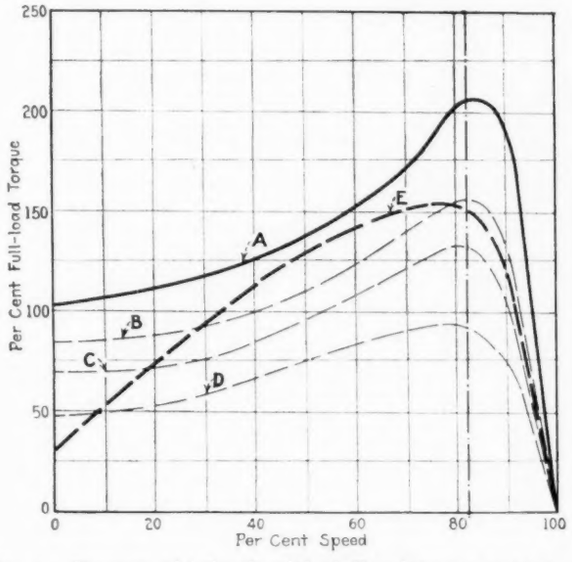


Fig. 3—Torque obtained with full-voltage starting and when starting with different values of resistance in series with the stator winding

be reduced to zero and increased to full values. While the motor is disconnected, the induced voltage in the stator may change its relation to the line voltage so that the two will be in the same direction instead of opposing, under which conditions the inrush current may be higher when the motor is connected to the line than the initial starting peak.

Curve *A*, Fig. 3, is the full-voltage speed-torque curve, and curves *B*, *C* and *D* represent the curves with primary resistance in the motor circuit. It is to be noted that the peak torques occur at about the same speed, which is approximately 85 per cent of normal speed. This shows that the general torque characteristic of the squirrel-cage motor cannot be changed through inserting resistance into the stator circuit, only the maximum values can be reduced.

For curves *B*, *C* and *D* it has been assumed that one fixed step of resistance is used in the motor circuit. If, however, this resistance is of the variable type, where the resistance is reduced as the motor comes up to speed,

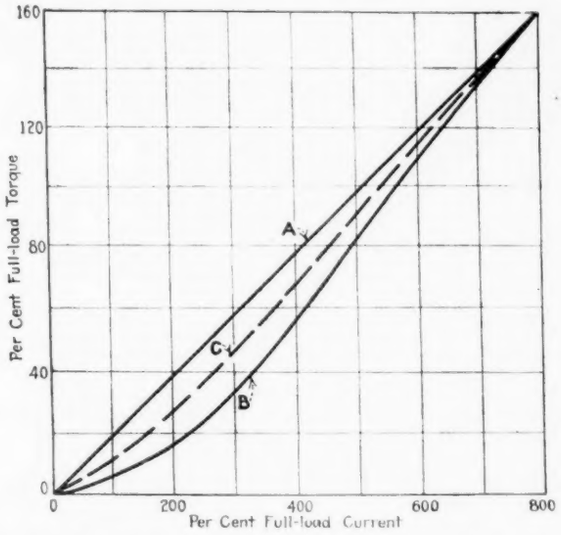


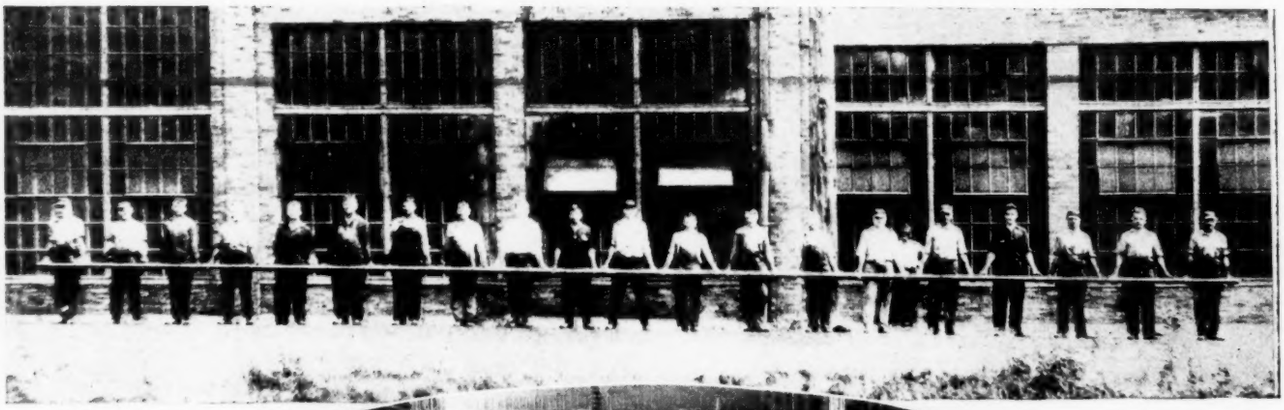
Fig. 4—Relation between torque and starting current

Curve *A*, when starting with a compensator; Curve *B*, when starting with resistance in series with the stator windings; curve *C*, modified compensator starting.

a much better speed-torque curve is obtained, which will look something like curve *E*. The initial torque is small but increases quickly, and stays at a high value without reaching the extreme maximum that the motor can produce. From these curves it can be seen that the squirrel-cage motor can be controlled during the starting period as to the torque distribution, so as to accelerate the load with the least strain on the motor, the driven machine and the power system.

Fig. 4 shows three curves of starting currents taken from the line for various values of starting torque. Curve *A* is the current drawn from the line by the compensator, and curve *B* represents the resistance-type starter. The higher the starting torque the closer will the two curves coincide and the smaller will be the advantage of the compensator over the primary-resistance starter as to current taken from the line. In fact, magnetic leakage and current losses in the compensator make its curve actually come near the dotted curve *C*.

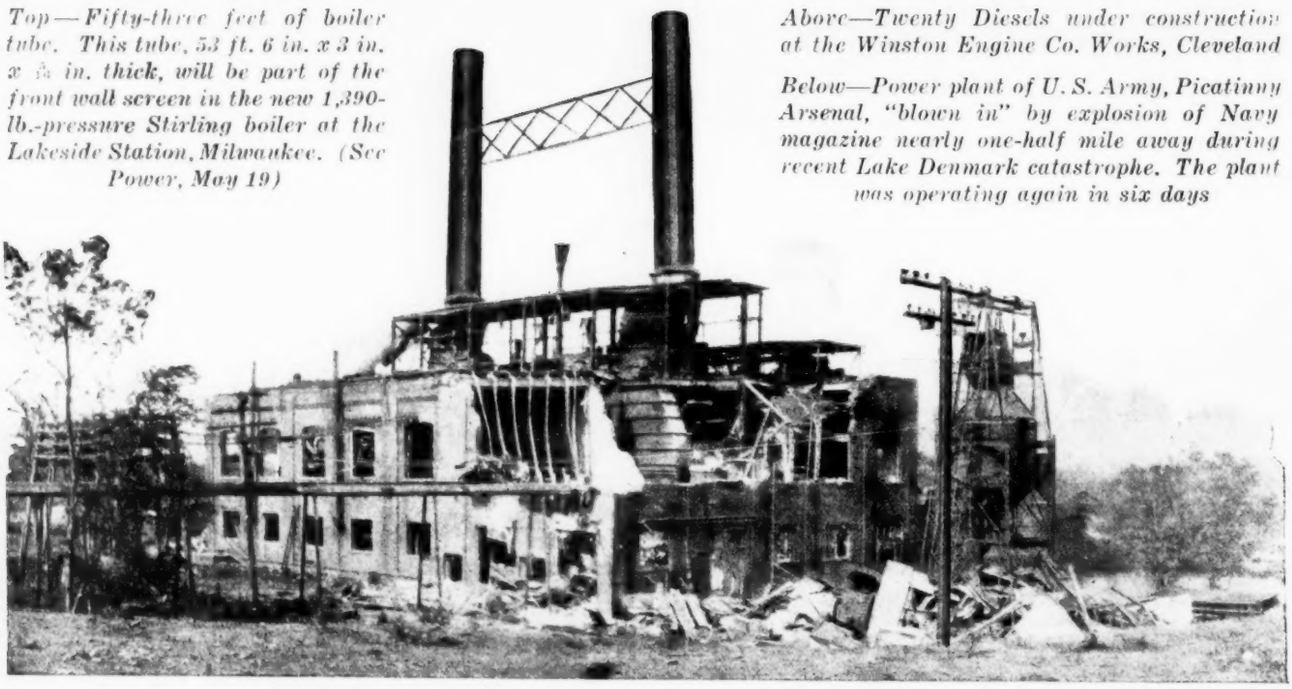
The power factor of a squirrel-cage motor is inherently less than unity, and during starting it is very low. A compensator adds its wattless current to that of the motor and tends to reduce further the power factor of the starting current. In a resistance-type starter the losses represent true power and tend to increase the power factor of the starting current. Of two equal currents supplied over a line, the one having the lowest power factor will cause the greatest voltage drop. Therefore, when starting a motor with a resistance-type starter, even if it does take a greater initial current than when starting with a compensator, the voltage drop in the line may not be much higher with the former than with the latter, on account of the more favorable power factor with the resistance-type starter.

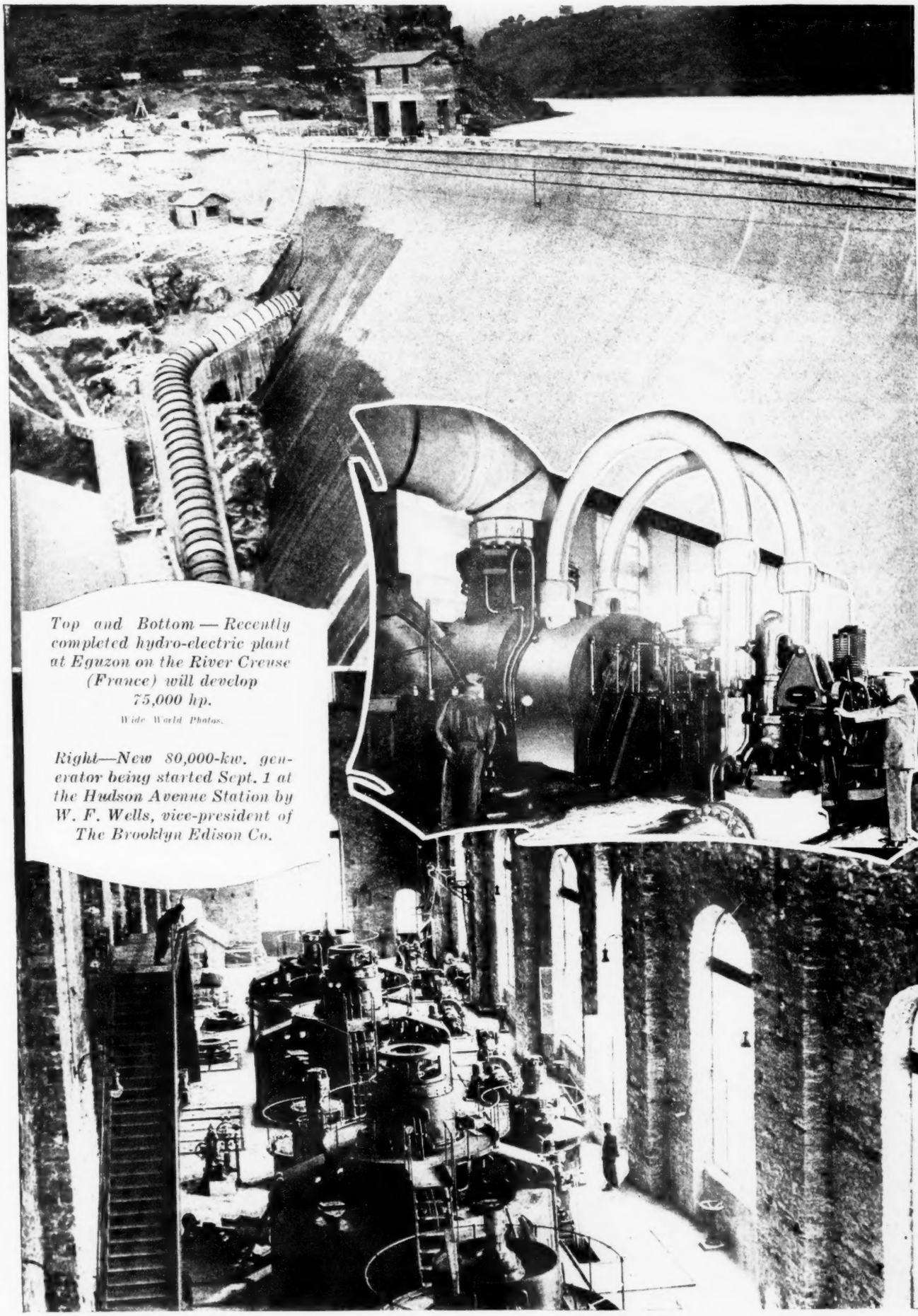


Top—Fifty-three feet of boiler tube. This tube, 53 ft. 6 in. x 3 in. x ⅜ in. thick, will be part of the front wall screen in the new 1,390-lb.-pressure Stirling boiler at the Lakeside Station, Milwaukee. (See Power, May 19)

Above—Twenty Diesels under construction at the Winston Engine Co. Works, Cleveland

Below—Power plant of U. S. Army, Picatinny Arsenal, "blown in" by explosion of Navy magazine nearly one-half mile away during recent Lake Denmark catastrophe. The plant was operating again in six days





Top and Bottom — Recently completed hydro-electric plant at Eguzon on the River Creuse (France) will develop 75,000 hp.

Wide World Photos.

Right—New 80,000-kw. generator being started Sept. 1 at the Hudson Avenue Station by W. F. Wells, vice-president of The Brooklyn Edison Co.

Tests Explode the Myth of Excessive Temperature Stresses in Diesels*

Temperature Distribution in Cylinder Walls Based on Volume and Time—Temperature Stresses at Starting and During Operation—Temperature Measurements in a Sulzer Two-Stroke-Cycle Marine Engine

THE design of internal-combustion engines must make ample provision for the safe distribution of temperature stresses in order to insure reliability in operation. A thorough knowledge of the temperature cycle is therefore essential to calculate the resulting stresses.

The temperature distribution is primarily based on the temperature of the burning gases, which are subject to severe periodic fluctuations in operation. The temperature change may be more than 1,800 deg. F., which produces a variable temperature distribution in the cylinder walls. The calculation of these temperatures requires the knowledge of the heat transfer to the gas and water side of the cylinder wall. This information can be at least partly obtained from indicator diagrams and the temperature of the cooling water. It should be noted, however, that the heat transfer from the gas to the cylinder wall during a working cycle is subject to very considerable changes.

It is of great importance, when considering cylinder-wall temperature, to remember that the heat transmis-

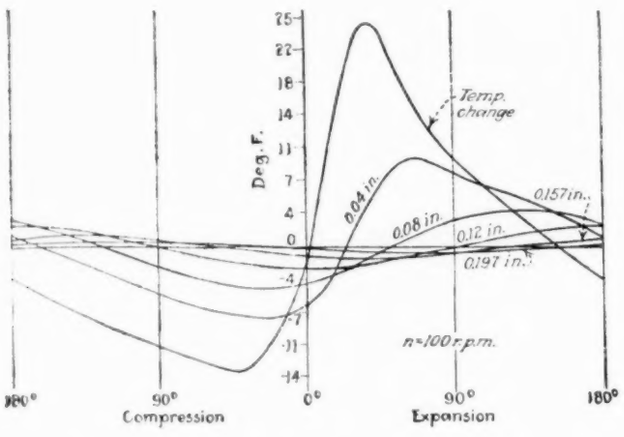


Fig. 1—Variation in temperature during a complete cycle

sion near the upper dead center, due to the high compression, is many times greater than the average heat transmission, because the temperature of an uncooled part of the cylinder wall is not only dependent on the momentary average gas temperature, but may easily rise 400 deg. F. above this. It is, therefore, natural to expect that the character of the temperature fluctuations will be greatly influenced by these great differences in heat transmission.

*Reported by Sulzer Bros., Diesel Engine Dept., Winterthur, Switzerland.

The calculation of the temperature distribution is based on the physical law that the amount of heat absorbed during a given temperature drop by a unit volume of a substance depends upon the specific heat of this substance.

The temperature conditions within the cylinder wall may be divided into the average temperature distribu-

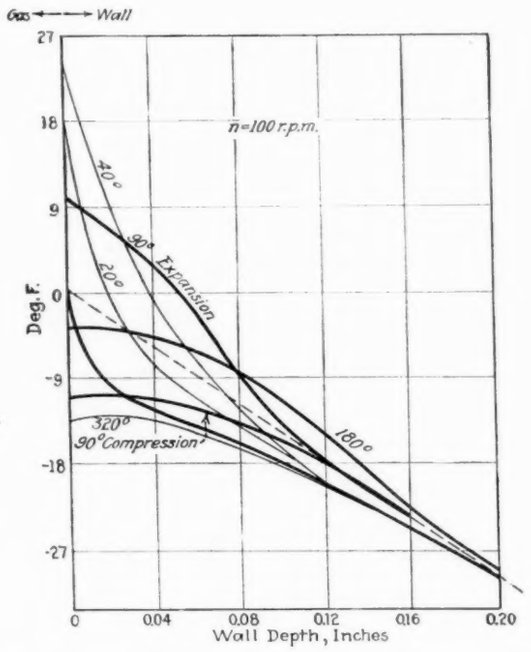


Fig. 2—Temperature variation in the cylinder wall

tion and into the superimposed distribution due to the periodic temperature changes which penetrate the wall from the gas side. The periodic temperature changes penetrate only a few hundredths of an inch into the wall, which makes it possible in the discussion to disregard the shape and dimensions of the wall.

A comparison is afforded by the fact that the surface temperatures follow the fluctuations in the gas temperature. The resulting temperature changes lie above the average temperature distribution, corresponding to the steady heat transfer.

On the surfaces in contact with the gases the temperature varies by an average amount, which does not rise more than 25 deg. F. or drop more than 15 deg., in spite of the enormous temperature changes of the gases. Inside of the wall the temperature fluctuations decrease rapidly under simultaneous shifting of their phases. At a depth of only 0.2 in. the total temperature fluctuation

does not exceed 1 deg. F. The temperature curves shown in Fig. 1 are drawn for different depths below the surface and show the temperature distribution in the cylinder wall at various crank angles.

A few typical temperature curves for the first 0.2 in. of depth are shown in Fig. 2. Although the gas temperature changes over a wide range, between that of the scavenging air and the highest combustion tem-

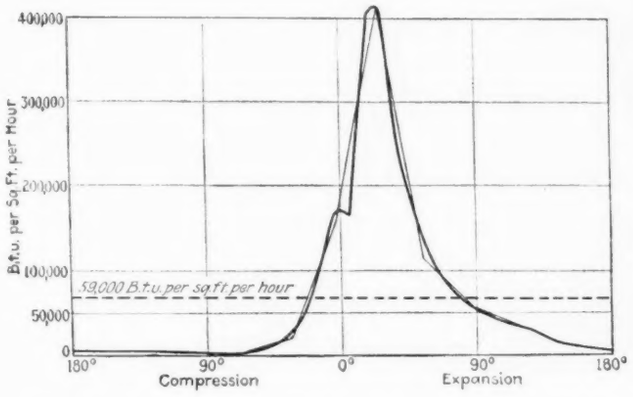


Fig. 3—Fluctuation in heat transfer during a cycle

perature, the temperature fluctuations within the wall are so slight that they influence the stabilized temperature condition practically only to a depth of 0.2 in. A little thought will show that the very great changes in the heat transfer to the wall which occur in spite of the slight temperature fluctuations, are in reality due to the temperature drop, as shown by the drop in the curve where the heat enters, instead of to the temperature itself. As will be seen in Fig. 2, this drop in the curve may be many times greater than that throughout the remainder of the curve. In other words, the entering heat fluctuates greatly and may reach a value several times that due to the stabilized heat transfer, as may be seen in Fig. 3. The entering heat is stored in the surface layers and distributes itself during the working cycle into the wall or, to a slight degree, it may stream back into the gases.

The curves are drawn for 100 r.p.m. and, when applied to an engine of a different speed, will change in proportion to the square root of the r.p.m. The temperature fluctuations and the resulting stresses are therefore most pronounced in slow-speed engines. In spite of the relatively small temperature changes, these stresses may fluctuate between 1,700 and 2,800 lb. per sq.in., at full load and 100 r.p.m. They may be considered as overlapping the average temperature stresses and are important.

The temperature variation in a smooth cast-iron wall 2 in. thick, on starting of the engine, is represented graphically in Fig. 4. These show the temperature conditions at from 10 seconds to 5 minutes after starting. During the warming up period considerably more heat is absorbed by the wall than is given up to the cooling water. Accordingly, the temperature on the gas side rises rapidly during the first few seconds, then more slowly, and theoretically reaches a condition of steady temperature after an infinitely long time. After five minutes has elapsed, the temperature is less than 30 deg. F. below the final steady temperature condition. The sharp bend at the beginning of the curves is of importance, as this indicates that additional temperature stresses are present.

In order to disregard the effect of shape and anchorage for the present, let one imagine a smooth and entirely free plate to be under the influence of a straight-line temperature drop. This would cause the plate to distort spherically without developing internal stress. Only when the temperature curve deviates from a straight line will temperature stresses develop. For instance, the sides of a perfectly square prism as high as the thickness of the cylinder wall which is free to expand in all directions, would cease to remain parallel when exposed to the uneven heating. But the elements that are directly beneath the surface of the engine cylinder, would be forced for symmetrical reasons to assume the shape of a truncated pyramid with smooth sides. The resulting elastic expansion and stresses change for every elementary layer throughout the thickness of the wall.

The application of this to the temperature values shown by the curves in Fig. 4, gives the temperature stresses after 10, 20 and 40 seconds after starting that are graphically presented in Fig. 5.

Compression stresses appear in both the gas and the water side, whereas the middle part of the wall is subjected to a tensile stress. It is notable that 10 seconds

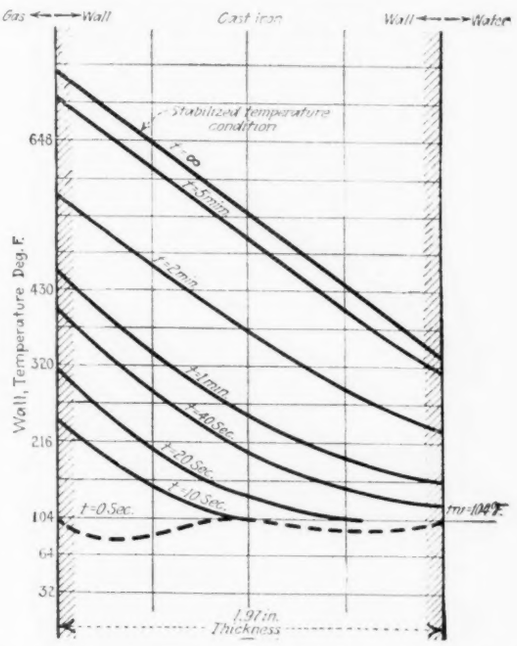


Fig. 4—Temperature changes immediately after starting engine

after starting the stresses on the gas side are particularly high and thereafter decrease rapidly, whereas the stresses on the water side are still small and increase for 40 seconds after starting. After this time they exceed the stresses on the gas side.

The compression stresses on the gas side reach their maximum value 10 seconds after starting and then decrease rapidly. The compression stresses on the water side reach their maximum value more slowly, but after 25 seconds become greater than those on the gas side, and likewise decrease upon reaching their maximum 40 seconds after starting. Unless the wall thickness is very great, the stresses occurring from sudden start-

ing under load are not dangerous, as the maximum tensile stress with a 2-in. cylinder wall are not high.

The temperature stresses corresponding to the stabilized temperature distribution can be computed only when the symmetrical axes of the piston cylinder

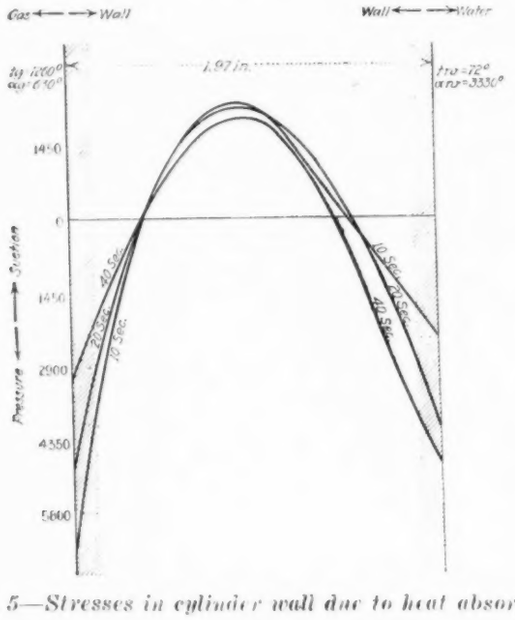


Fig. 5—Stresses in cylinder wall due to heat absorption

head and cylinder liners are not interfered with structurally by valves or ribs.

In order to predict safely the character of the temperature stresses, it will be advantageous to design the cylinder heads, piston and cylinder liners with symmetrical contours. It is only necessary to consider the antithesis of such a design as illustrated by a cylinder, the symmetry of which is seriously affected by the many perforations necessary to accommodate valve cages. Here cracks are likely to develop, which plainly shows the undesirability of adopting any design for which the stresses cannot be computed in advance. In designing large engines, the ability to predetermine accurately the stresses is of vital importance. Inasmuch as many difficulties have been overcome through experience gained by their builders, there is now every reason why the remaining troubles should be investigated and the proper remedies sought.

In order to determine temperature distribution experimentally, thermocouples were located in 30 different points in the cylinder liners, piston and cylinder head of a two-stroke-cycle Sulzer marine engine in the test block at the Winterthur Works. These measurements were not confined to average temperature readings, but all temperature variations during a revolution were observed and very accurately reproduced by photographic means. Professor Naegel, of Dresden, designed the necessary apparatus at the Dresden laboratories, and kindly permitted its use for the tests. The following description of the tests will be of interest.

The tests were conducted on one cylinder of a four-cylinder engine, having a cylinder bore of 23.62 in. with a piston stroke of 41.73 in. At 100 r.p.m. the rating of the four cylinders was 1,350 brake horsepower. The locations of the thermocouples are shown in Fig. 6; those on the gas side were located 0.2 in. below the gas contact surface. These thermocouples were made up with copper and "Konstantan" wires 0.19 in. in diameter. For every 180 deg. F. temperature difference at the soldered points a potential of approximately 0.5 millivolts was generated. The couples were inserted in ground conically shaped plugs fitted into the cylinder wall. The wires passed through capillary glass tubes that were cemented in two adjacent holes 0.078 in. in diameter and extended to 0.019 in. below the surface.

The temperature measuring points in the piston required very careful installation of the leads to the observer's table containing the instruments. The individual leads passing through the water space inside of the piston were assembled in an insulated waterproof cable containing 24 wires, which was carried down the side of the piston rod. At two measurement points in the upper piston ring 0.019 and 0.59 in. beneath the rubbing surface, it was also necessary to take the side play of the ring into consideration.

Fig. 6 shows graphically the recorded temperatures in regular operation at 100 r.p.m. and under full load. The lines of constant temperature drawn in the diagram plainly indicate the heat transmission to the cooling water. The highest temperature in the cylinder head and piston was about 570 deg. F. At the end of the cylinder liner beyond the travel of the piston ring, the maximum temperature of 630 deg. F. was recorded in the wall. The temperatures in the piston head plainly showed the effect of the fuel injection with cold air and

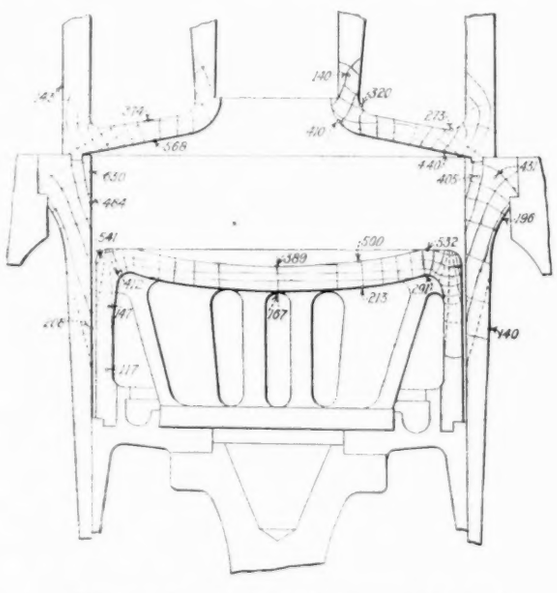


Fig. 6—Location of thermocouples and recorded temperatures

the gradual beginning of combustion. The center part of the piston was always the coolest. At light loads the highest piston temperature is recorded about midway between the center and the circumference, whereas the piston is hottest along the circumference at heavy loads, due to the longer combustion periods.

The highest temperature recorded in the cylinder liner was at the end, beyond the piston ring travel, and therefore presented no lubricating problem. At a lower point over which the piston ring passed, a temperature of 484 deg. F. was recorded.

*Boiler Feed-Water Purification—XII**

Getting Rid of Dissolved Gases by Deaëration

Dissolved Gases Are a Vital Factor in the Corrosion of Feed Lines, Economizers and Boilers. Under Proper Conditions These Gases May Be Removed by Mechanical or Chemical Means with Substantial Savings. Read How It Is Done

By SHEPPARD T. POWELL
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IT HAS been known for a long time that certain gases dissolved in water accelerate its corrosive properties, and that when the gases are removed the corrosive tendencies of the water are retarded to a great extent. The problem of minimizing corrosion in boilers and appurtenances has focused attention upon gas removal as a form of feed-water treatment.

Feed-water heating has been practiced widely in the past, and where this has been done in open heaters the gas has been partly removed. The percentage of dissolved gases remaining in water after heating to 212 deg. F. may, however, be sufficiently great in many cases to cause active corrosion of boiler and economizer. Practically complete removal of dissolved gases from feed water is essential in order to stop corrosion. Within the last few years, a number of appliances for degasification have been designed and put into practical operation. Many of these appliances eliminate practically all dissolved gases.

Solution of Gases by Water

The two most important gases which accelerate corrosion when dissolved in the feed water are oxygen and carbon-dioxide. Water rapidly dissolves atmospheric air, containing oxygen, nitrogen, carbon-dioxide and other gases up to the point of saturation at a particular pressure and temperature. The solution of air in water follows Henry's and Dalton's laws, namely, that the solubility of a gas in a liquid is proportional to its partial pressure[1] and inversely proportional to the temperature. Although air consists of a mechanical mixture of several gases, the solution of each gas is in proportion to its share of the pressure and as though it were acting as a single gas.

The amount of air taken into solution in water is influenced by other constituents dissolved in the water at the time the solution of the gas takes place. For instance, distilled water will absorb more oxygen at a given temperature and pressure than a water such as may be obtained from a natural source. Likewise, a hard water will absorb less of this gas than a softer water. Sea water will be saturated with a smaller amount of oxygen at a given temperature and pressure than a fresh-water supply under similar conditions.

The area of the exposed surface of the water influences the rate of absorption greatly. Eliminating other influencing factors, the greater the exposed area of water in contact with oxygen, the greater will be the absorption in a given period of time.

The primary object in the deaëration of feed water is the removal of dissolved oxygen, since this gas is the most important single factor in the corrosion of metal by natural waters. Corrosion may be influenced by many conditions, but as a general proposition the corrosive properties of the majority of water supplies become negligible after the water has been freed of dissolved oxygen.

However, waters containing the same amount of dissolved oxygen may not have the same corrosive reaction, since the mechanism of corrosion is a complex phenomenon, subject to many influencing factors. The presence of various constituents in water which deposit to form protective coating on the metal surface will reduce the corrosive action of dissolved oxygen to a marked degree. The temperature of the water, the velocity of the water in contact with the metal and the acidity or alkalinity of the solution, are factors of considerable importance in the rate of corrosion. Disregarding other corrosive factors, however, it is a well established fact that the rate of corrosion of metal by water is proportional to the oxygen content of the water in contact with the metal.

Theory of Degasification

There are two general types of degasification apparatus. These may be designated as (a) mechanical or physical and (b) chemical. This classification has been adopted generally although not strictly accurate, since both types function partly by chemical action and partly by mechanical action.

Chemical deoxygenators operate by removal of the oxygen from the water by oxidizing iron or steel or other substances. Deoxygenation may take place in hot or cold solution. The rate of oxygen removal by chemical means is slower in cold water than in hot water. If sufficient time is allowed for the water to remain in

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, Softening Water by Chemicals"; Aug. 3, "Hot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites Fit In"; Aug. 24, "Boiler Compounds"; Aug. 31, "Priming and Foaming"; Sept. 7, "Embrittlement—What Causes It"; Sept. 14, "Evaporators, Their Design and Operation."

[1] According to Dalton's law, each gas or vapor in a mixture exerts its specific pressure and is not influenced by the pressures exerted by the other gases.

contact with the iron or other metal used for deactivation purposes, complete removal of oxygen may be effected even at low temperatures.

It is customary in most appliances of the kind first to heat the water and then pass it through a bed of steel scrap or special forms of iron or steel trays. The metal is contained in an iron or steel shell not unlike a pressure filter. The process has not been adopted to

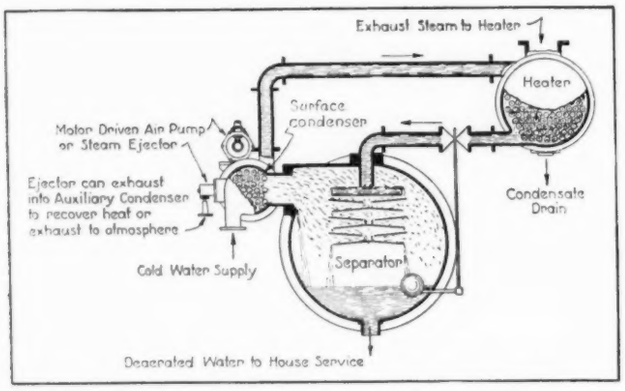

Exhaust Steam to Heater
Heater
Surface condenser
Motor Driven Air Pump or Steam Ejector
Ejector can exhaust into Auxiliary Condenser to recover heat or exhaust to atmosphere
Condensate Drain
Separator
Cold Water Supply
Deaerated Water to House Service

Fig. 1—Diagrammatic cross-section of Elliott deaërator

any extent in this country for deaëration of feed water, but has been employed to some extent for reducing the corrosive properties of hot water in heating buildings and for similar uses.

Mechanical Deaërators

A number of different types of deaërators based on mechanical principles are in general use. The majority of plants for the deaëration of feed water are of this type, since they are as a rule betted adapted for this kind of service. In one type of deaërator the gases are removed by explosive boiling of the water as it flows through the apparatus.

A deaërator of this type is shown diagrammatically in Fig. 1. The cycle of operation is as follows: The preheated water is discharged to the separator and, owing to the drop in temperature at this point, a portion of the water flashes into steam which is passed to the surface condenser. Here the vapors are condensed and the air removed by air pump or ejector. The cooling water for this condenser is the cold water to be deaërated which is partly heated prior to entering the heater.

The water enters the condenser attached to the deaërator from the supply main. In making the water passes, it picks up all the heat from the explosive boiling which is taking place in the separator. For every pound of water that enters the separator there is an equal amount passing through the circulation of the condenser, since the two are in series. The cooling water in the condenser, therefore, picks up the heat from the boiling process and from the condenser flows to the heater, taking the heat along with it. In the heater it is warmed to some predetermined temperature, and then admitted under gravity flow to the separator. In the separator there is a vacuum maintained corresponding to a temperature at least 22 deg. below that of the entering water.

When the water enters the separator, it is superheated in relation to the vapor space that it enters. It therefore boils explosively, since the heat is already available to accomplish the boiling. After the water has been partly pulverized, it flows over pans arranged in steps to give maximum agitation, and then falls down into the water space, where it is stored for a few minutes ready to deliver to the supply.

The condenser, which was mentioned as the first piece of apparatus in the path of the flow, is significant from three viewpoints. First, it recovers the heat of the explosive boiling, so that the process amounts to a continuous circulation of heat from a higher to a lower temperature, without waste of heat. The condenser further recovers the vapors from the boiling process, and returns them through the stream of steam into the separator, thus saving all the water. Finally, it separates the condensable vapors from the non-condensable gases, and permits the air pump or ejector to handle only non-condensable vapors, thus lightening the duty of this device.

The deaërator shown in Fig. 2 is based upon the principle of reboiling or scrubbing the feed water by means of live steam. The gases in the water are removed by being forced upward with the rising bubbles of steam. The apparatus consists of a steel shell, in the upper portion of which are a series of trays as in an

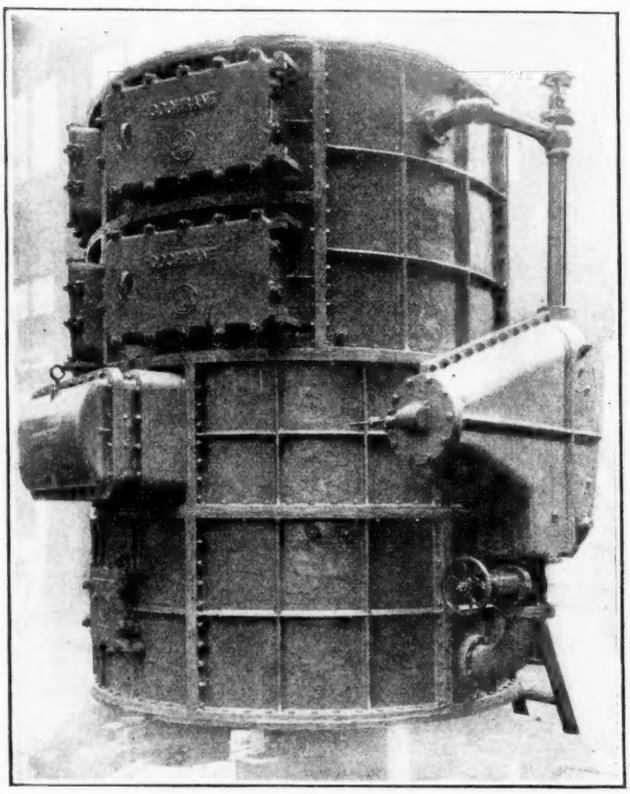


Fig. 2—Cochrane deaërator employs "reboiling" principle

ordinary open feed-water heater. The water enters the deaërator at the top and splashes over the trays. The steam enters the equipment at the bottom through perforated pipes or jets and passes upward through the water in the storage space, heating the water falling over the trays above. The gas with some vapor is removed by an ejector, the vapor being condensed and returned to the system. The trays are of the countercurrent type and so arranged that the gases and vapor

passing to the vent travel between the trays in a direction contrary to that of the water falling from one tray to the next.

Chemical Deaërators

A deaërator which functions by removal of the oxygen by oxidizing iron or steel is shown in Fig. 3. This apparatus, termed a deactivator, consists of a steel tank

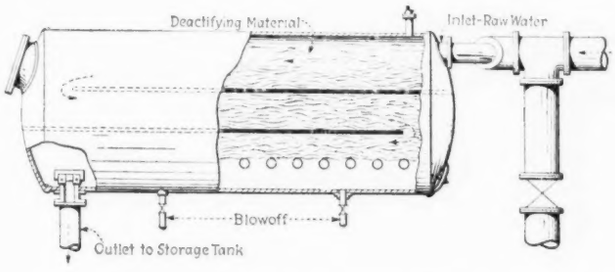


Fig. 3—Elliott deactivator removes oxygen by allowing it to rust sheets of steel

in which are a number of layers of steel laths or perforated sheets over which the water flows.

As indicated in the drawing, the tank is baffled with two horizontal plates to prevent short-circuiting from the inlet to the outlet. The water may be discharged into the apparatus from open or closed feed-water heater and it is employed usually in conjunction with such appliances. When the temperature of the water is lower than 212 deg., live steam may be employed to raise the temperature prior to passing through the deaërator. This method of operation is warranted when there is an insufficient amount of exhaust steam and when economizers are not used. Deaërators operating on this principle have been used more widely abroad than in this country for the degasification of boiler feed water.

The deactivating material becomes exhausted in time and must be replaced when an appreciable portion of the steel sheets is converted into rust. The length of time before the sheets will require replacement depends upon the amount of water passed and its oxygen content. As a rule, the deactifying material will last for several months. The apparatus requires blowing down every two or three weeks in order to remove the iron hydroxide (rust) which has formed on the surfaces of the metal.

European Practice

A number of different types of deaërators have been designed and operated in Europe, for correcting the corrosive property of feed water. At least four different degassers have been used in Germany on a practical scale and a number of others have been employed in France and England.

The deaërator shown in Fig. 4 combines violent agitation and reduction in pressure to effect removal of the dissolved gases. The water is drawn through a tube or tubes with alternating contractions and expansions throughout their entire lengths. The free ends of the tubes are connected to a vacuum pump. At the base of the tubes, which are submerged in the water, is an adjustable air pipe. When the air pump is operated, the air (which has been deactified by passing through a deaërating filter) rises with the water in the tube with contracted walls. Due to the shape of the column and to the gases there is a violent agitation of the water, thus releasing the contained gases, which are removed by the vacuum pump.

The apparatus shown in Fig. 5 functions by raising the temperature of the water by means of steam and recirculating the water through the apparatus. Vertical baffles aid in the separation of the gases. The released gases are extracted from the top of the deaërator by means of a special arrangement of air-relief pipes. A feature of the apparatus is the storage of deaërated water in an atmosphere free from oxygen or other gas which might contaminate the water.

The deaëration of feed-water makeup is accomplished in some plants by utilizing the vacuum maintained in the main turbine condenser. Deaëration may be effected in cold water by this means with a fairly simple equipment. In a Balcke deaërator of this type the degasing chamber is maintained under partial vacuum by connecting it to the condenser, resulting in the removal of air as the raw water is sprayed into the equipment. The partly deaërated water is then mixed with the main condensate.

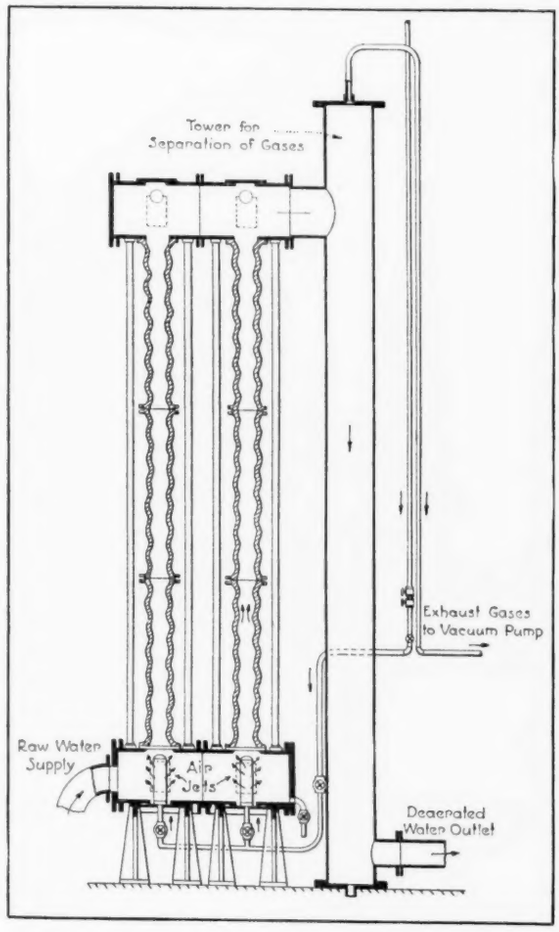


Fig. 4—Deutsche Sanitätswerke deaërating apparatus

The type and general arrangement of the spray tank varies in different installations. Similar results may be obtained by merely spraying the raw makeup directly into the condenser, as is done in some installations.

Efficiency of Deaërators

Open heaters may be operated so as to eliminate practically all oxygen from feed water when the station heat balance so functions that the heating may be car-

ried up to 212 deg. or higher in the heater. Where it is desirable for economy to raise the temperature of the feed water in the heater to, say, only 160 deg. F., as when economizers are utilized, it may be desirable to effect degasification by chemical deaërators or by deaërating equipment in which the removal of the contained gases is brought about by maintaining the deaërator under a partial vacuum. It is difficult to effect a high percentage of air removal from feed water in open heaters without considerable venting, whereby an appreciable loss of vapor may result. This condition may be overcome by the use of a deaërating heater.

The amount of iron that may be converted into rust by the oxygen carried by water is very great. For example, anywhere from 1,800 to 2,500 lb. of rust may

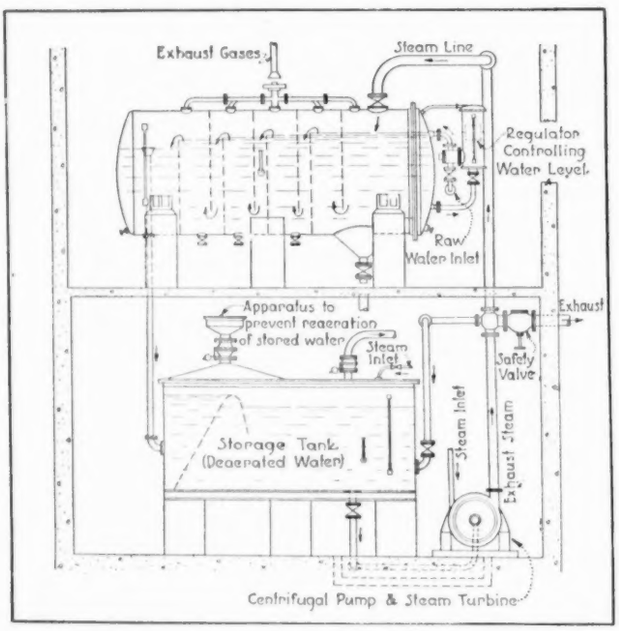


Fig. 5—Balcke hot-water deaërator

result in a year, when the feed-water consumption averages 10,000 lb. per hour and the dissolved oxygen content approximates 0.06 per cent by volume. The weight of the rust produced will depend upon the particular oxide of iron that is formed.

Trade wastes entering a stream used for boiler feed water may increase or decrease the gases contained in the water. An unusual case of corrosion of steel-tube economizers from a high concentration of oxygen and carbon dioxide in the feed water was believed to be the result of activated sludge[2] discharged into the water.

The majority of mechanical deaërators are operated so that there is no appreciable loss of steam or waste of heat. This is accomplished in different ways, depending upon the design of the apparatus. In some units the heat is utilized by preheating the water as it enters the deaërating chamber, and in other equipment it is used as the condenser for the last stage of an evaporator.

In some cases the deaërator may be utilized as one stage of a multiple-stage feed heating arrangement. This will depend, of course, upon the type of deaërator used and the heat balance of the station.

[2]The activated-sludge process consists of treating sewage by pumping air through the liquid or using other means of aëration whereby the organic products contained in it are oxidized and the liquid is rendered sufficiently stable to permit its discharge into a river without danger of creating a nuisance.

The removal of gases from feed water is primarily for the purpose of reducing corrosion. Deaëration is desirable also for the economy resulting from the elimination of gases from surface condensers. Gases in condensers reduce vacuum by blanketing the tubes and by adding gas pressure to the vapor pressure. They also increase the load on the air pump.

Tests made by the author showed that the corrosion of iron by aërated water was greater after an exposure of four hours than results with deaërated water at the end of 18 days.

Although it is claimed by some investigators that a reduction in the dissolved oxygen content of water to from 0.05 to 0.10 cubic centimeters will result in practically no corrosion from this cause, there is an increasing tendency to eliminate this gas completely with a permissible maximum of 0.02 c.c. per liter. Properly designed and operated deaërators may accomplish these results, and many installations are being operated in this way.

Mechanical deaërators, when properly designed and adjusted to meet the steam-station requirements, eliminate practically 100 per cent of the dissolved oxygen and free carbon dioxide and may reduce also a certain amount of carbon dioxide which is loosely combined with certain alkaline salts in the water.

It is practically impossible to study separately the specific effect of oxygen as an accelerating corrosive agent when present in water with free and half-bound carbon dioxide. It is a well established fact, however, that the aggressiveness of a water in corroding metal is influenced to a marked degree by its reaction as measured by the hydrogen-ion concentration, which in turn is influenced (in natural waters) by the equilibrium of the free and half-bound carbon dioxide contained in the supply. For this reason the partial reduction of the bicarbonate alkalinity by deaëration has a far-reaching effect in arresting the corrosive tendency of the water in addition to the deoxygenation that takes place in the process.

Deaëration of water will reduce the corrosive property of water in so far as this action is the result of dissolved gases. The aggressiveness of water in attacking metal, although caused or accelerated frequently by oxygen and carbon dioxide, may be the result of other ingredients in the water. Free mineral acids or compounds that produce an acid condition may at times be responsible for the corrosive property of a water. In this case deaëration will inhibit the aggressiveness of the water merely so far as the condition is aggravated by the dissolved gases.

All feed-water supplies are improved in respect to the tendency to corrode metal when deaërated, although the corrosive property of the water may not be entirely eliminated.

Deaëration of feed water is now generally conceded to be a necessity in power-plant practice. The desire for complete elimination of oxygen from feed water has resulted largely from the increasing use of economizers, and the use of feed water free from scale-forming solids.

SATURATED AIR has a density less than dry air at the same pressure and temperature. For example, under a total pressure of 14.7 lb. per sq.in., and a temperature of 100 deg. F., the density of dry air is 0.071 lb. per cu.ft. and the density of saturated air is 0.069 lb. per cu.ft.

How Industrial Power-Plant Boilers Are Fired

Hand firing is still used in one-half of the industrial plants. Thirty-five per cent use automatic stokers.

THE answers to the power-plant questionnaire sent out by *Power* to three thousand industrial plants were used to show the general distribution of boilers in the industries in two charts that were published in the May 18, 1926, issue. In this analysis the same questionnaire returns are studied from the viewpoint of firing methods, which are charted here in terms of per cent for each industry.

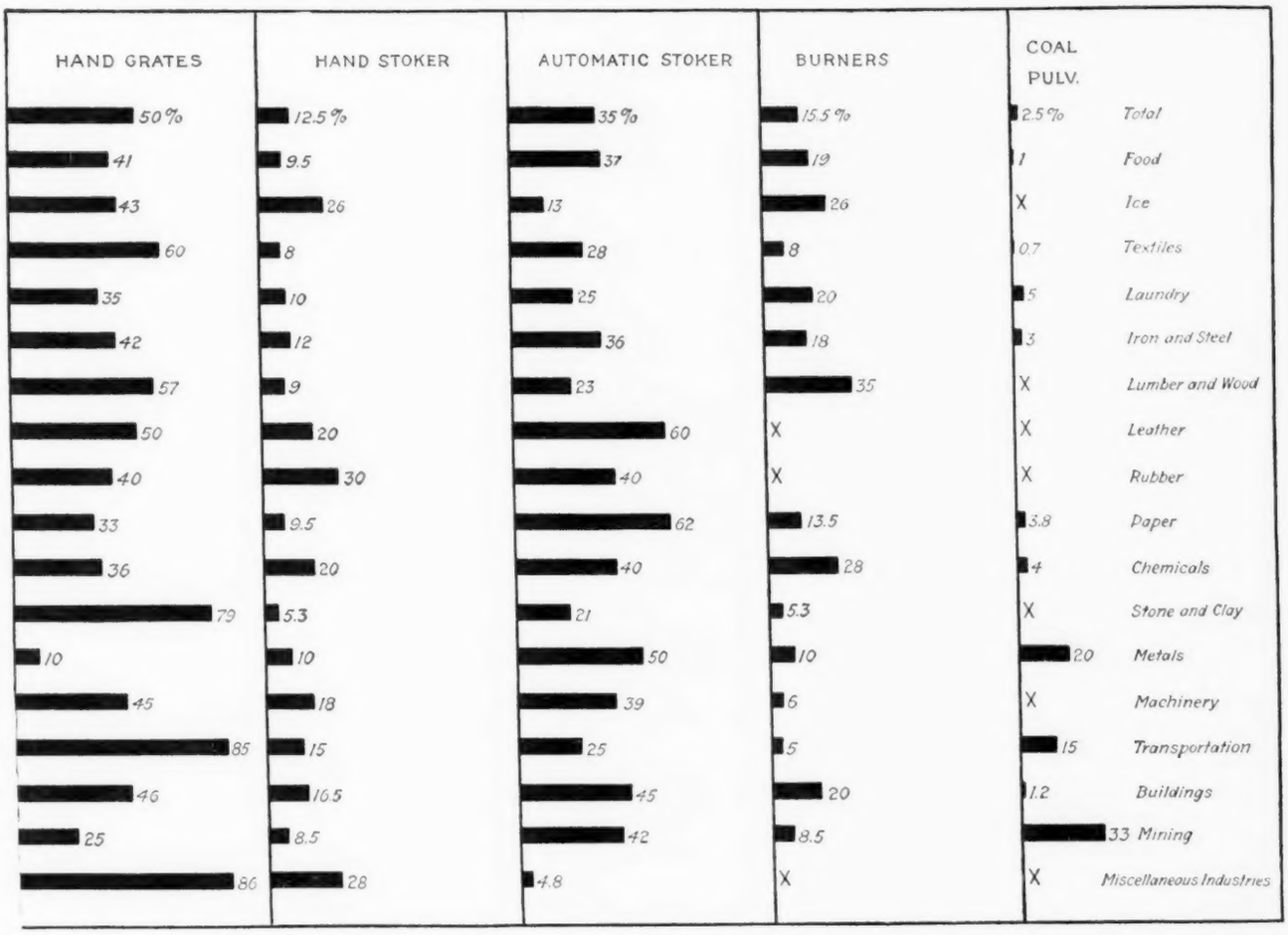
The equipment for the five main types of firing is shown at the heads of the five chart divisions. The names of the industries are listed to the right, starting at the top with their combined total. In each column is shown the per cent of each type of firing, in accordance with the questionnaire returns.

Thus, for all industry, 50 per cent of the companies use hand grates, 12.5 per cent use hand stokers, 35 per cent use automatic stokers, 15 per cent use burners and 2.5 per cent use coal pulverizers. Due to there being several methods used in single plants in many cases, the percentages will not balance out evenly.

The column headed burners pertains to the type of equipment used for oil and gas, principally oil in this case, with one exception, that of the industry under lumber and wood. Here the burners referred to have principally to do with the firing of sawdust and shavings.

Under coal pulverizers the mining industry shows 33 per cent of its boilers equipped. This figure is doubtless quite high owing to the comparatively small number of returns from this branch of industry and the large number of pulverized-coal plants that reported.

It will be interesting to watch the developments of this chart as time goes on, to see the changes in balance among the five types of firing. Burners, of course, will be governed largely by availability and cost of the fuel they use. Automatic stokers, coal pulverizers and hand stokers will look largely to the 50 per cent of existing hand grates, as well as to new installations, but there will doubtless be a number of changes in the proportions of each method as new developments are made.


HAND GRATES
HAND STOKER
AUTOMATIC STOKER
BURNERS
COAL PULV.
50 % 12.5 % 35 % 15.5 % 2.5 % Total
41 9.5 37 19 1 Food
43 26 13 26 X Ice
60 8 28 8 0.7 Textiles
35 10 25 20 5 Laundry
42 12 36 18 3 Iron and Steel
57 9 23 35 X Lumber and Wood
50 20 60 X X Leather
40 30 40 X X Rubber
33 9.5 62 13.5 3.8 Paper
36 20 40 28 4 Chemicals
79 5.3 21 5.3 X Stone and Clay
10 10 50 10 20 Metals
45 18 39 6 X Machinery
85 15 25 5 15 Transportation
46 16.5 45 20 1.2 Buildings
25 8.5 42 8.5 33 Mining
86 28 4.8 X X Miscellaneous Industries

Use made of various types of firing in the industries in terms of per cent

Over-Fire Air Injection With Underfeed Stokers

THE experience of the Milwaukee Electric Railway & Light Company, summarized from its test reports, shows how to reduce smoke and increase efficiency in installations having small furnace volume

By M. K. DREWRY
Assistant Chief Engineer of Power Plants, The Milwaukee Electric Railway & Light Company

IN THE last few years much has been done on the problem of over-fire air injection for bettering combustion conditions. In general, this is accomplished by introducing the air at a point in the furnace at which there is a deficiency of oxygen, the air also having sufficient velocity to stir up the products of combustion as far as possible and so to reduce stratification.

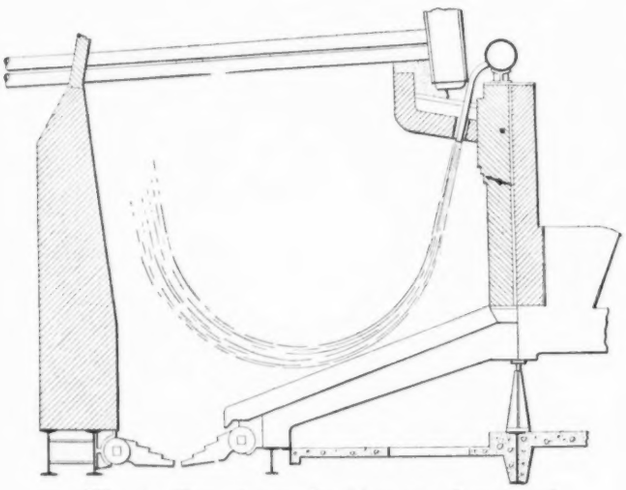


Fig. 1—Ten air nozzles blow air downward from the ignition arch

Usually this experimental work has been carried on with chain-grate stokers.

At the Commerce Street Plant of the Milwaukee Electric Railway & Light Company, a preliminary study of an underfeed stoker installation with a limited combustion space indicated that a similar stratification occurred with this type of stoker. In the middle of the nest of boiler tubes in the first pass, there was no oxygen present over the coking portion of the fire and the CO_2 and CO were both high. Over the ash portion of the fire the CO_2 was low and the oxygen high. It was not until the third pass was reached that the turbulence had succeeded in eliminating this stratification. The result was too low a CO_2 content leaving the boiler, and losses due to combustible gases as evidenced by smoke.

It was believed that not only could the smoke nuisance be relieved, but also, with proper over-fire air injection, the boiler efficiency could be bettered. To demonstrate this, a furnace with a very limited combustion space was equipped for such air injection.

Fig. 1 shows the installation diagrammatically. Ten nozzles, equally spaced across the furnace, directed the air downward from the arch, through the path of the gases arising from the coking portion of the fire. These nozzles were fed from an air header which in turn was connected to the wind-box of the stoker.

In order that the air might create a sufficient turbulence, the nozzles were designed for an air velocity about the same as is customary with pulverized-fuel burners—65 ft. per sec. About 5 per cent of the total air required for combustion, entered over the fire. This ratio was maintained about constant for, as the rate of driving decreased, the wind-box pressure, and thus the pressure in the nozzle header, was cut down, and the nozzle flow was reduced.

Fig. 2 shows the analysis of gas samples taken midway over the stoker and at one-foot intervals between

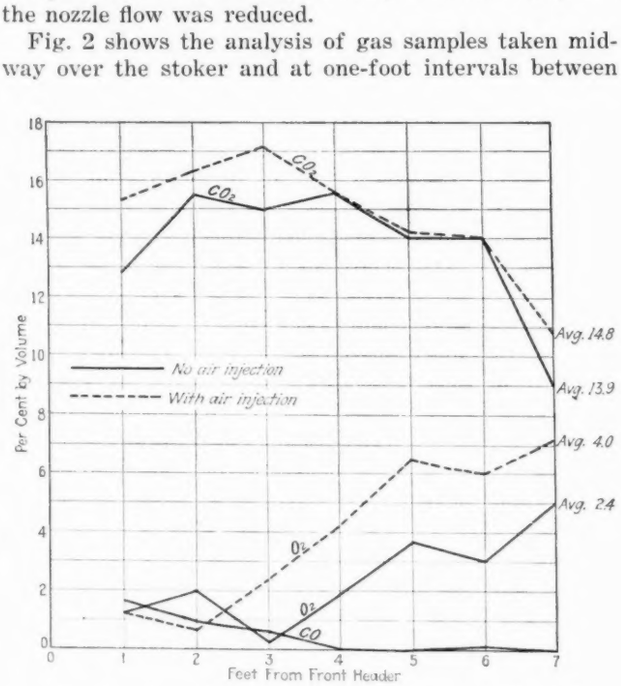


Fig. 2—Over-fire air injection increases the CO_2 content and promotes complete combustion

Each curve is for samples above the center line of the stoker. Similar curves were obtained at the sides of the furnace.

the front header and the baffle. For comparative purposes these samples were taken with and without air injection. With the air injection there was more oxygen in the gases. This was accompanied by a higher CO_2 content, and no trace of CO was observed. Smoke also was absent.

Similar traverses taken at the sides of the boiler indicated the same improvement in these sections. With air injection, the CO_2 content of the gases jumped from an average of 10.9 per cent to 13.3 per cent at one side and from 11.6 per cent to 12.5 per cent at the other side. Combustion was complete here, likewise.

The results of the over-fire air injection were: (1) Increased CO_2; (2) complete combustion; (3) secondary combustion in later passes eliminated; (4) soot diminished, which means cleaner flues and thus lower outlet temperatures; (5) the maximum rating increased, due to less draft loss because less air passes through fuel bed and CO_2 is increased; (6) smoke eliminated; (7) maintenance decreased, because there is no secondary combustion.

In many localities the reduction in the smoke nuisance alone would justify an installation of this type. However, there is an additional economy gain which, in the foregoing installation, is estimated as giving an increment of 7.2 per cent in boiler efficiency. Most of this is a result of eliminating the incomplete combustion.

Electrical Trouble Shooting in the Power House

By J. Elmer Housley

Trouble-shooting is a fine art. At least it should be developed as one of the fine arts in operating the power house. Many incipient electrical troubles give only a gentle hint that a "blow-up" is in the offing. If trouble shooting can be confined to looking for these gentle hints, many anxious moments are avoided and interruptions to service are minimized. To get down to cases, recently the automatic control on a 40-hp. direct-current 250-volt motor on an eight-stage governor oil pump would trip out apparently "without cause" at infrequent intervals. A hint was sufficient.

Analyzing the bare statement. What would make a direct-current motor trip out with a 200 per cent current setting on the overload relay? Overload? Does the unit turn over by hand freely and are the thrust bearings in good shape? Yes. An overload on the pump may be dismissed for the moment. What will cause an excessive current on a direct-current compound-wound motor? Well, principally two things—an open shunt-field winding and a flashover on the commutator. Is the commutator clean and are the brush-holders free from burns? Yes. So, by elimination the possible sources of trouble are brought down to the shunt-field circuit. Let's look it over:

Starting at the control panel, here is a loose connection where the lug is bolted to the panel. A taped connection where the lead enters a conduit is untaped and it is found tight. At the motor the field lead enters a speed-control rheostat. Taking the rheostat off the mounting reveals a nut loose where the lead is bolted to the terminal on the back of the rheostat. Untaping the lug connection at the motor shows the stranded wire from the motor has all except two stands broken where the wire is soldered into the lug. There was not enough tape on this connection to prevent the stranded wire bending sharply where it was soldered to the lug. The connections between field coils and where the other end of the field wire is attached to the armature lead are all tight.

Here were three chances for an open field circuit which would have caused the motor to race if the relay had been set any higher. Evidently, it was the loose connections that gave an intermittent reduction of field current and caused a heavy current to trip the overload relay. After the necessary repairs were made, the current setting on the overload relay was reduced and no further irregularities occurred.

Grounded circuits give rise to unusual troubles at times. The most puzzling case I recall was the burning off of a lead wire on a temperature-indicating instrument. The control wiring and temperature instrument wiring tested O.K. After exhausting all theories as to why it happened, an inspection of the control battery room indicated that two cells had been given an overcharge, but without taking the cells out of the battery circuit; here was a clue. The control battery was 250 volts, and on this day the control circuits were switched to the 125-volt section at the opposite end to where the two cells were being overcharged. The charging machine generated 250 volts and the two cells were being charged through a resistance. A test for grounds was made on the charging generator, and the positive lead showed a dead ground. It so happened that the two cells were at the positive end of the battery. As voltages in series add, the 250 volts of the generator added to the 250 volts in the battery made 500 volts potential on one side of the instrument to ground, and one of the leads inside of the instrument arced to ground and burned off.

At another time a rather eccentric behavior of a freight elevator was reported. It would seem to drop a few feet, then suddenly stop and then proceed in regular fashion. After watching at the motor, it was found that it would race and spark excessively for a few seconds at a time. This was diagnosed as a floating open in the field circuit, as the motor was a heavily compounded elevator type. A loose lug was found on one of the field-contact relays, which proved to be the cause of the trouble.

Don'ts in Drying out Motors

Drying out of motor windings after they have been submerged in water is a job that operating men not infrequently have to contend with. The methods of doing this are about as numerous as the operators that do the work. Passing an electric current through the winding to heat it is one way that cannot be recommended, although it is used. The current tends to leak between turns of the coils, through the insulation, and in this way copper is deposited in the insulation by electrolytic action. Cases are on record where motors that had been started after a bad wetting, could not be baked out to restore the insulation, the only remedy being to rewind the machine.

Baking the machine in an oven of some kind is the best practice. It is essential that the oven be well ventilated in order to get rid of the moisture driven out of the windings. If the oven is not ventilated, it will be found impossible to dry the windings, and overlooking this point is frequently the cause of difficulty in restoring the insulation to normal. One of the best checks on how the drying process is progressing is to test the insulation resistance. If it is found that the insulation's resistance is slow in returning to normal after eight or ten hours' baking at a temperature of about 200 deg. F., it will be well to look carefully into the ventilation of the oven. Where machines have been submerged in water while running, it will generally be difficult to restore their insulation qualities by baking and rewinding will usually be necessary before the machine will be fit for service again.

How To Align Long Shafts

By A. B. NEWELL

IN THE erection of large machines, such as engines direct connected to extended shafts, the erectors of a certain manufacturer found it difficult to establish a straight line, although perfect alignment was necessary to the success of the job.

Several methods were commonly employed. One was to call in a civil engineer, who would establish the line with a transit. This eliminated the ordinary mechanic. Another method was to set a series of plates with small holes in them at equal distances along the line and juggle these about until a beam of light could be seen through the series of holes. The ordinary mechanic could do this, but trying to get all the plates within a few thousandths of an inch of where they actually had to be set, was nerve-wracking. A third method, equally as difficult and perhaps not quite so reliable, was to take a bright new piece of steel wire and stretch it. Then at regular intervals the sag was lifted out of it until a light shining at one end of the wire would reflect a glistening beam the length.

To eliminate the objectionable features of the several methods, the machine shown in Fig. 2 was built, the essential specifications of which are given in the sketch. To establish a table giving the sag along lines of various lengths a long trough, or water canal, was built and filled with water. A float in the form of a substantial little pontoon with a stiff spar was put in the trough of water. The machine was set up and a wire stretched over the water. Then the pontoon was floated along under the wire and the distance from the top of the spar to the wire was accurately measured.

Distance from End, Ft.

Length of Wire in Ft.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
250	14	27	38	49	59	67	69	81	85	88	91	92	92	91	88	85	81	69	67	59	49	38	27	14
240	13	26	37	47	56	64	71	76	80	83	84	85	84	83	80	76	71	64	56	47	37	26	13	
230	13	26	36	45	53	60	66	71	74	77	78	78	77	74	71	66	60	53	45	36	26	13		
220	13	24	33	42	50	56	62	66	69	70	71	70	69	66	62	56	50	42	33	24	13			
210	12	22	31	40	47	53	58	62	64	66	66	64	62	58	53	47	40	31	22	12				
200	11	21	30	38	45	50	54	57	58	58	58	57	54	50	45	38	30	21	11					
190	10	20	28	35	40	46	49	51	52	52	51	49	46	40	35	28	20	10						
180	10	18	26	31	35	39	41	42	43	42	41	39	35	31	26	18	10							
170	10	18	26	31	35	39	41	42	42	41	39	35	31	26	18	10								
160	10	17	23	28	32	35	37	38	37	35	32	28	23	17	10									
150	9	16	22	27	30	32	33	33	32	30	27	22	16	9										
140	8	15	20	25	27	29	30	29	27	25	20	15	8											
130	8	14	18	22	24	25	25	24	22	18	14	8												
120	7	12	16	19	21	22	21	19	16	12	7													
110	6	11	14	16	18	18	16	14	11	6														
100	6	9	12	14	14+	14	12	9	6															
90	5	8	11+	12	12	11+	8	5																
80	4	7	9	9+	9	7	4																	
70	4	6	7	7	6	4																		
60	3	5	5	5	3																			
50	2	3	3	2																				
40	1	2	1																					
30	1+	1+																						
20	1																							

Data covers; No. 7 Piano wires 0.018 in. and a weight of 27.75 lb.

Figures in squares give sag in 64th. of an inch

Fig. 1—Tare table for alignment wire

To use the machine, the height of the wire or the center to work from, is established at both ends. The machine is bolted up so that the wire in passing over the fairlead will be approximately where it is wanted. The holes in the brackets are made considerably larger than the studs or bolts that hold it in place. By setting up fairly tight on these bolts, the machine can be bumped up or down or sidewise until the wire leading over the fairlead is right. In the meantime the wire has been reeled out and hooked at the distant point, then drawn tight by means of the crank and held with the pawl and ratchet until the weight is hooked to the pulley. Then the ratchet is released and the weight holds the tension on the wire.

With the wire stretched in this way, supports for the sag pieces are placed along it every ten or twenty feet. In placing these supports they are made to touch but not lift the wire. Then pieces of metal made in accordance with the thickness given in the table are placed on top of the supports and under the wire which will be lifted to a straight line.

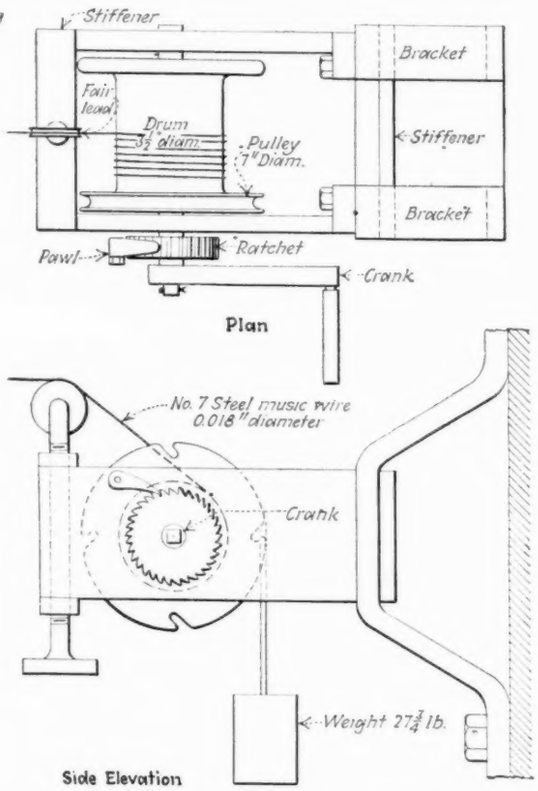


Fig. 2—Apparatus used to tighten wire

As an example, a wire 50 feet long will have a sag piece $\frac{1}{32}$ in. thick 10 ft. from each end and another $\frac{3}{64}$ in. thick 20 ft. from each end, or in about the middle of the wire.

This method of establishing a straight line is used by one of the largest firms in the mechanical field in America and has proved itself absolutely dependable.

Help the Other Fellow

LOTS of money is being spent in the larger power plants to improve their operation and to solve some of the many problems that arise. Trained experts keep after things until they develop a satisfactory solution and get it going in regular service.

Why stop there? To be sure, the local needs are cared for, and the organization that did the work has reaped all the material benefits there are, be they large or small. But there are thousands of power plants in the country, and any specific problem must be a cause for anxiety in many of them that are without the facilities for investigation and experiment. Why not tell them about methods that have helped elsewhere?

A fine example of this spirit of helpfulness appears on another page of this issue, in a short article telling how the Milwaukee Electric Railway & Light Company conquered smoke and improved the efficiency of an underfeed stoker-fired boiler with an old low setting with scant combustion volume. There are many boilers that need similar treatment and could easily be cured of bad smoking and fuel waste.

It would be splendid if our larger concerns would do this sort of thing frequently. Everybody gains.

A Boiler-Operating Code Needed

MANY of the states have adopted the Boiler Code of the American Society of Mechanical Engineers as applying to new boilers. As a consequence the purchaser and the operator of a new boiler have a feeling of confidence that the vessel has been designed with the proper factor of safety, is made of suitable material and incorporates acceptable workmanship. It is almost universally agreed that the insistence of a boiler being built to a code's requirements removes most, if not all, of the uncertainty formerly felt by the purchaser of a chance boiler, and offers a considerable protection against explosions due to poor material and workmanship.

Unfortunately, no matter how safely a boiler be built, unless it is properly installed and operated it will always possess an element of danger. To provide an additional safeguard, existing boilers should be brought under a standard code of requirements covering the fundamentals of installation and operation. If all parts of a boiler were open to inspection, corrosion would be discovered early enough to permit proper remedies to be made, and ruptures of mud drums, such as occurred in the New York City explosion described in the news pages in this issue, would disappear. With every boiler fitted with safety firedoors no longer would a ruptured tube be so fatal to the fireman. No boiler should be installed so low as to require the fireman to work in a pit below the floor level, for it is practically impossible to escape steam burning in case of even minor ruptures.

Increasing the Diesel's Efficiency

FUEL consumption records of modern oil engines are but slightly, if any, better than results obtained from engines built twenty-five years ago. Inasmuch as the efficiency of the steam plant has steadily increased, many engineers feel that there is a corresponding opportunity to decrease the fuel consumption of the Diesel engine. But is this true? Even if one uses as the basis of comparison the air cycle, a Diesel operating at usual compression pressures and air-to-oil ratios attains over seventy-five per cent of the theoretical, which compares favorably with the engine efficiency of a modern steam plant. On the surface it would appear that there is opportunity to recover part of the missing twenty-five per cent, but this hope is based on the assumption that the air cycle is theoretically sound. It is well recognized that the specific heats of the cylinder contents vary during the cycle to an extent that the theoretically possible efficiency falls considerably below that of the air cycle. Using the proper basis, the actual Diesel has an efficiency approximately eighty per cent of the ideal.

Suggestions have been made that, by increasing the atomization, the amount of fuel burned in the cylinder could be increased. The indicated engine efficiency decreases with an increase in the fuel charge, and if a gain be possible with a smaller air-to-oil ratio, it is obtainable only through a reduction in the mechanical losses.

Increasing the engine speed, all other factors remaining constant, will bring about a decrease in mechanical losses up to a certain speed, beyond which the friction increases, and unfortunately this optimum speed is not greatly above that customary. Mechanical losses are made up in the main of piston-ring friction, and if engine speeds were increased, probably one-half the usual number of rings per cylinder could be dispensed with, at a reduction in frictional losses.

Suction losses are frequently as much as three to five per cent of the indicated horsepower, and designers would do well to give closer examination to the problem of valve porting and air manifolds.

An equally important point to be considered is the temperature of the suction air. While the actual temperature has never been accurately determined, it is undoubtedly well over two hundred degrees. If the air charge could be as low as atmosphere at the beginning of compression, its weight would be greater than at present, permitting a greater amount of fuel to be burned per cubic foot of cylinder volume, which would in turn permit the use of a smaller engine for a desired output. The opportunities for increased efficiency are confined in the main to increased piston speeds, decreased frictional losses, lower suction losses and reduced air charge temperature and not to any revolutionary designs.

College Opens—For Everybody

FALL is here. College opens. The campus is again alive with students. These big boys (referred to by their girl friends as "college men") are about to continue an experience whose value is differently rated by different individuals, but which all agree is most enjoyable in one way or another. Meanwhile, some look on with a feeling akin to envy. "If I had only had their chance," they reflect. For, while the college product is not invariably admired, the opportunities of the college student for self improvement are generally rated highly by those who never had them.

There is a grain of truth in this point of view. It is easier to acquire an education—or more exactly to acquire certain fractions of an education—in such an atmosphere of relief from mundane duties and worries. But the advantages offered the college student are often given undue weight. The wisdom of the ages is not to be mastered in four years, nor should it be forgotten that the college graduate must accept a four-year handicap in practical experience as compared with the high-school graduate who goes directly to a job. The grammar-school graduate has been immersed in practice for eight years when the college man is just leaving the sheltering arms of his *alma mater*.

The man with a job who makes proper use of his spare moments can pick up a lot of book knowledge in eight years or even in four. He has a college of his own where he is dean, professor and student. He picks his own courses, buys the books and periodicals he needs, sharpens his pencil and his wits and goes to it. In this age of the printing press no man need remain uneducated. Knowledge is power, but degrees are not. In college or out, knowledge comes only to those who will meet it half way.

More Prevention and Less Cure

HOW far one may go toward preventing trouble in power equipment is a question on which there can justly be a wide difference of opinion. There is one thing sure, that much can be done to prevent failures and there has been sufficient experience in trouble-prevention methods to prove their high economic value. If a piece of equipment is neglected and let run until something breaks, the damage done may be much more extensive than if the defect had been located and repaired before a failure occurred. In addition to this, the inconvenience of having the equipment suddenly put out of business and the cost in lost production must be kept in mind.

An electric motor is used under all conditions of temperature, moisture, oil and dirt. Its insulation is affected to a greater or less degree by these destructive elements, and as successful operation depends largely upon the condition of its insulation, it is essential that this part of the equipment be kept in good condition. In no class of service are motors subjected to more severe treatment than in railway work. By careful attention to treating motors with insulation varnish and then baking them, it has been found possible to prolong the life of the windings greatly. Such treatment has been to a limited degree applied to industrial motors with good results after they have gone into service, but the practice is by no means as general as it should be.

However carefully a motor may be insulated, the insulating material will deteriorate after a period. Even under the best of conditions the winding is subjected to certain movements due to changes in temperature, magnetic and mechanical forces, which, no matter how small, tend to crack or wear the insulation. If these small defects are allowed to exist, they provide openings for moisture, oil and dirt to injure the insulation permanently. The frequency of the preventive treatment will vary with conditions, but the object should be to keep insulation up to standard. Under some of the most severe conditions, more rigid preventive methods have made serious troubles practically a thing of the past.

Why Such Expectations from Atomic Energy?

THE energy bound up in the atom has been the source of many flights of imagination. At the recent convention of the American Chemical Society one of the addresses that received a large amount of attention was devoted to this subject. Claims were made that if it were discovered how to release this energy, it would revolutionize the present social and economic order of things, a limitless supply of energy would make over the world and every man would have time to taste of the joys of life.

This might be true if it were possible to obtain this energy by saying "hokus pokus" or some such magic words, but there is no precedent to indicate that nature delivers goods from her storehouse on any such worthless check. Whenever man has taken anything from nature, it has always been at considerable expense. Then why should we think that some day the atom may give up its energy in a way that will revolutionize the whole order of human existence?

Learning how to utilize the energy in coal and falling water has changed the standards of living for those in certain sections of the world, but it has been a slow process which has taken one hundred and fifty years. One of the biggest problems in this whole development has been the discovery of means of utilizing this energy economically, and the problem is by no means completely solved. If a commercial process were discovered whereby the energy stored in the atom could be made available, the utilization problem would still be with us.

Even if such a method were discovered, there is no good reason for believing that it would be any cheaper or as cheap as obtaining energy from the heat in fuel. There has been much speculation on using the energy delivered to the earth by the sun, the energy of the tide and wind, and from other sources, but these for the most part are waiting for someone to show how they may be used economically. The same economic laws that govern all commercial undertakings apply with equal force to using the energy in the atom.

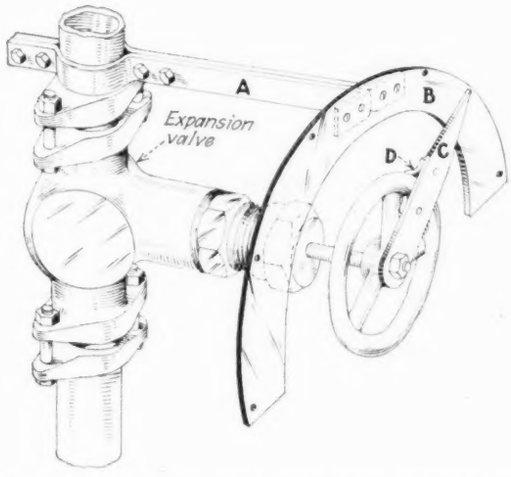
No one wants to be an easy mark. To be too easily "sold" by glib talk unbacked by facts is a mark of unfitness for responsible positions in the engineering world. But some are equally unfitted because they are too "hard boiled." The dangers of this mental attitude are just as great but less commonly recognized. Some men will trust nobody, believe nothing. They are so afraid of getting "stung" that they miss countless opportunities to save money and better their own positions. As in most things there is a happy medium. Demand proof—insist on facts—but meet a likely proposition half way. Give it a little real consideration.

Practical Ideas From Practical Men

Indicating Dial on Expansion Valve of Refrigerating System

In the operation of an ammonia compression refrigerating system it is convenient to know how far to open the expansion valve to produce certain conditions. A simple but effective arrangement is shown in the illustration.

The clamp *A* is made from two pieces of strap iron bent as shown and clamped together onto the pipe. The ends are brought out until they are directly above the



Pointer shows how much expansion valve is open

valve handle and are bent again as shown, to form two wings. A segment of sheet metal for the dial *B* is then fastened to the wings with flat-headed machine screws. The dial has three or four small tapped holes for the purpose of fastening a piece of white cardboard over it for a face. The pointer *C* is made of sheet metal with a large hole to fit the valve stem, and a small U-clamp *D* holding it to the valve handle. It now remains to log the dial face by placing a pencil mark and suitable notation at the top of the pointer for various conditions, and the result is a serviceable operating guide.

R. E. GOULD.

Urbana, Ill.

Repairing a Dam After Three Years of Service

Being resident engineer during the rebuilding of a dam at Boney Falls, Michigan, it occurred to me that some of the difficulties encountered might be of interest to other readers.

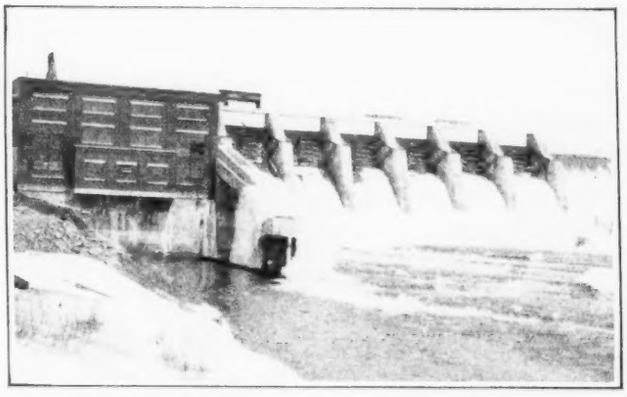
The dam shown in the illustration consisted of a 200-ft. concrete spillway, with six tainter gates, and with earth fill at each end of concrete masonry. The total head was 50 ft. The generating equipment consisted of three wheels, each of 1,750-kva. capacity.

The dam was completed in 1922, and the following spring a slight seepage was noted at points from six to eight feet below the crest. This seepage became steadily worse until the winter of 1924-25, when sections of the dam above where the seepage was noted pushed out to about two inches from the original location, and it was necessary to resort to calking with felt, oakum, etc., in order to operate the wheels part time.

In the spring of 1925 it was decided to remove the defective concrete and repour. In places it was necessary to remove about eight feet of the concrete, which in certain spots was found to be white and soft, caused apparently by "late" cement at the time the dam was constructed. It was thought that the type of mixer used and the methods of pouring might have been partly responsible for this condition.

After the defective section had been removed, a wedge-shaped groove was cut in the center of the dam, 1 ft. deep, 12 in. wide at the top and 14 in. wide at the bottom. A number of holes were drilled 30 in. farther down, and then reinforcing steel was grouted, using care to keep the steel 6 in. or more from the surface of the dam. Before the bolts were grouted, all sections were thoroughly cleaned by washing with a strong solution of muriatic acid, which was later removed by scrubbing with water.

Before the new concrete was poured, a plaster of "neat" cement was applied with brushes, just ahead of the concrete to insure a permanent bond. The concrete was made "rich" and washed gravel was used instead of stone. The crest was finished by using 7-in.



View of plant with dam and spillway

channel irons for supporting the slash boards. The job, when completed, made a satisfactory leakproof structure.

At the time the dam was being repaired, we installed a new wheel on one of the generators, which necessitated changing the gates and tube, but resulted in a considerable improvement in the over-all efficiency of the plant.

S. V. ROGERS.

Munising, Mich.

Operators Partly Responsible for Poor Performance of Plants

Disagreeable is the lot of the engineer who takes charge of an old run-down plant and works conscientiously to improve its operating condition. I speak from experience, having tried it more than once, and I am perfectly willing to try it again. After the task is accomplished, there is a pleasant sense of work well done, but the path is a rough and tortuous one.

At one time I had charge of the steam plant of a New England textile firm, being hired for the purpose of improving conditions. The mill ran 6 days and 5 nights a week, giving none too much time for overhauling equipment. On the day run one operating engineer and three firemen were employed, while two firemen were able to handle the night load. Usually, the engine was stopped at 6 p.m. as there was sufficient water power most of the year for the night load.

Nine boilers were used for both day and night loads, although the low steam demand at night could easily be cared for by five boilers. All boiler settings were in bad shape, and the CO_2 averaged only 8 per cent. I had my own Orsat and one draft gage, there being no instruments in the plant for making tests except a water meter on the feed line.

The firemen were barely able to speak English, and it was out of the question to try to talk to them about ways of improving firing methods. All of them had been in the plant over ten years, and the operating engineer had been there thirty years, never having operated any other plant. The combustion chambers of all boilers were filled with soot to a point where the draft loss was excessive. After cleaning out the soot, I used it to fill in the space in the side walls and thus reduced the air leakage. The furnace walls had to be nearly all rebuilt and I reduced the height of the bridge walls to 18 in., as they were so high that the gases were directed against the girth seam. After using a tube cleaner on the boilers, we removed 53 barrows of scale.

The next in order was an investigation of the firing methods. I had plugged the air leaks and cleaned boilers inside and out, so I figured we should be able to get from 12 to 14 per cent CO_2, but was surprised to get barely 9 per cent. No amount of argument could make the firemen depart from their usual method of doing the work. At the first attempt to discuss fuel saving they simply shrugged and talked among themselves in their native tongue. I tried the expedient of throttling the dampers to give about 0.20 in. of draft over the fire, thinking that they would be forced to fire less fuel at one time and give more attention to their fires. This proved a boomerang, for two of the men went to the office at once and asked for their time, saying they were being called upon to do too much work for nothing. As they were not the right type of men, I made no effort to induce them to stay, but after promising the third fireman double pay to fire the remainder of the week alone, I started a search for the type of man who would take real interest in boiler-room work. I picked a young fellow of the nationality of my foreman, and in two days he was producing better results than the men who left, although he had never fired a boiler before.

Finally, I borrowed a flow meter from the superintendent of another plant in town and connected it to the No. 1 boiler and had the firemen take turns firing this boiler. With a clean fire we could get a steam flow of 11,000 lb. per hour from one boiler with 0.25 in. draft. After trying every draft from 0.2 to 0.35 and thickness of fire from 4 in up to 10, we found that the thinnest fire and lowest draft pressure were most economical, but the question confronting me was to make the men do what I wanted without standing over them constantly.

An evaporation of 9 lb. was the highest we were able to get, and as we had a recording water meter on the feed line, the standard of performance had to be a certain evaporation rather than the percentage of CO_2, so I set the figure $8\frac{3}{4}$ lb. as the standard of evaporation after calibrating the water meter. Two men were firing the boilers where three had been used, and I told them that as long as the evaporation was held at $8\frac{3}{4}$ the pay of the third fireman would be divided equally between them.

The day before payday I requested the superintendent to approve the extra pay for the men, pointing out that the labor expense was no greater and showing him the coal slips for the week totaling fully a third less than the week before I came. He was doubtful and submitted my request to the treasurer, where it came to an unqualified refusal. "But you are forcing me to break my word to these men," I said. "The better showing made in my department is due to the promise of extra compensation." I was promptly told that my job was to run the boilers and they would manage the payroll.

Regretfully, I went back and told the men of the failure of the plan. Though disappointed at this, they absolved me of blame and said they would finish their shift that day, but would not report on the next day.

Only one thing stopped me from writing my resignation—I would not quit under fire and continued doing the work of three men for another week. Then the firm received an order for goods that meant continuous operation at full capacity for a year. I was questioned as to whether the engine and boilers could carry the increased load and I assured them that they could, but stated that if I was to remain on the job I must be given authority to settle labor questions in my department. This led to a conference being held at which the president agreed to look into the matter and asked me to state in writing my requirements in the line of help and material. Just before closing time I sent my report to him, the principal suggestions being strict adherence to the pay arrangement made with my day firemen and the same arrangement for the other shift, and the recommendation that he compare our steam costs for the past year with that of the plant where I had borrowed the flow meter.

The next day I was sent for and my previous request for a draft gage and flow meter for each boiler was granted and the president told me that he had visited the other plant and found they were paying firemen more for an 8-hour day than our men got for 12 hours. He said further that he believed the 8-hour shift would be the correct thing in our plant, and I agreed with him. Had I suggested such a thing directly they would have turned me down, but by indirect suggestion, the idea appeared to come from him. The higher evaporation with cheaper coal in the neighboring plant told him forcibly of the folly of his past policy.

While these incidents are valuable as experience, they add immeasurably to the burden of the engineer.

Thompsonville, Conn. G. H. HART.

Comments from Readers

Causes of Turbine Vibration

I have been interested in the letters on "Causes of Turbine Vibration" which have appeared recently, and particularly the one by A. J. German in the Aug. 17 issue.

The procedure we follow in warming up turbines, differs from the one explained by Mr. German, in that we do not establish the vacuum at once, but open the throttle slowly until the rotor revolves, then close it down to a point where the rotor just keeps revolving. In this way the machine is gradually warmed throughout, and if needed badly the generator field is energized. This, together with no vacuum, causes the inlet pressure to increase sufficiently to allow the steam temperature at the exhaust end to be much higher than it would be if the vacuum were established. In other words, there is less temperature difference between the inlet and the exhaust end. After running this way for 10 or 15 minutes, the vacuum is slowly established and bled to hold at 18 or 20 in. (we have a small hand valve on the side of the exhaust end), then the throttle is opened up slowly and the turbine is brought to approximately three-quarter speed. The vacuum is later brought up to normal, and this causes the turbine to come up practically to speed. As soon as the governor comes into action, the machine is ready for the load and with little if any vibration.

G. C. TRAPP.

New Haven, Conn.

Buckling of Boiler Tubes

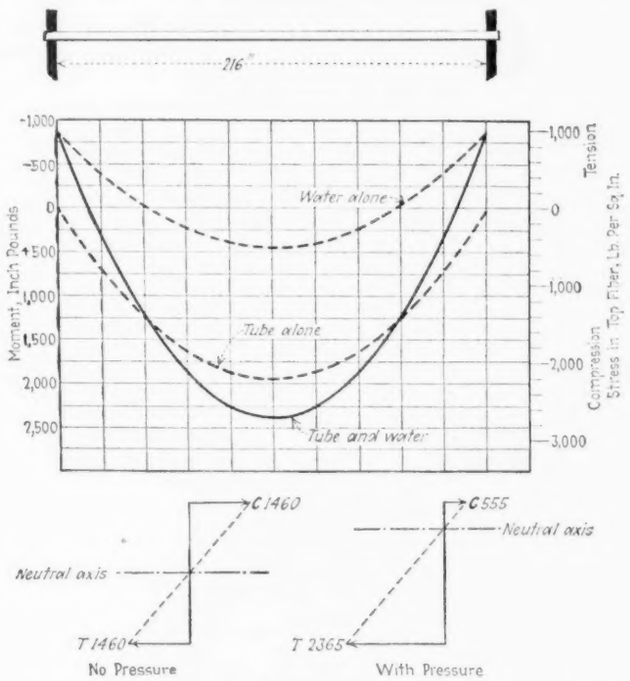
A careful consideration of the problem of buckled boiler tubes shows that it is more complicated than C. O. Sandstrom indicated in his article in the July 13 issue. Assuming an 18-ft. 3½-in. diameter No. 11 gage tube, we can consider this when empty as a free beam, supported at both ends and uniformly loaded with its own weight, approximately 72 lb. The moment of inertia I will be 1.54, and the section modulus S equals 0.84. The maximum bending moment will be at the center.

$$M = \frac{WL}{8} = \frac{72 \times 216}{8} = 1{,}944 \text{ in.-lb.}$$

The variation in the bending moment is shown by a dotted line in the sketch. From the usual formula maximum deflection is $\frac{5WL^3}{384EI} = 0.204$ in.

The tube is expanded in the header or water leg with this deflection and becomes, as far as further loads are concerned, nearly a beam with fixed ends which has a different strength formula. The bending moments introduced by the water load, 49 lb. total, are shown in the sketch dotted and the total moments by a solid line. The maximum moment will be 2,383 in.-lb., and either graphically or by calculus we can find the average moment, compressing the upper fibers and stretching the bottom fibers, to be 1,290 inch-pounds.

The bending moment divided by the section modulus gives us the fiber stress in the outermost fibers, and the average stress equals 1,460 lb. per sq.in. In other words, the top fiber is under an average compression of 1,460 lb. per sq.in. and the lowest fiber under a similar tension. We come to the unbalanced pressure now, and as the area is 7.116 sq.in. and the pressure 150 lb. gage, this will be 1,065 lb. This pressure will put a tension on every square inch of the tube metal of 905 lb. This will decrease the average compression in the top fiber to 555 lb. and increase the average tension in the bottom fiber to 2,365 lb. per sq.in. It will be noted that this pull on the tubes because of the unbalanced boiler



Bending moments of boiler tube considered as a beam

pressures displaces the neutral axis from the center of gravity. It will probably have a tendency to straighten the tube.

The shortening of the top fiber $= \frac{fL}{E} = \frac{555 \times 216}{30{,}000{,}000} = 0.004$ in.

The elongation of the bottom fiber $= \frac{2{,}365 \times 216}{30{,}000{,}000} = 0.0173$ in.

Bottom fiber exceeds upper fiber by . . . . . 0.0213 in.

The expansion of steel is 0.0000067 per unit length per degree F., but as the tubes and drum from which the headers are suspended all are at practically the same temperature, this expansion is uniform and introduces no new stresses. For every degree the 18-ft. tube will expand (0.0000067) (216) = 0.001447 in. Then $\frac{0.0213}{0.001447}$ = 14.8 which shows that if the top fiber of the tube

becomes 14.8 deg. hotter than the bottom, it will equal it in length and the tube will be perfectly straight. If the temperature difference exceeds this amount the top will be longer than the bottom and the tube will arch.

We know that steam is not as good a heat absorber as water and that stagnant steam is less effective than moving steam. We know that the lower tubes generate the greatest amount of steam, that the steam is lighter than the water, that it has the quality of adhesion and, further, that the lower tubes are in the hottest part of the furnace and have the greatest trouble in disposing of their steam. All the conditions indicate the possibility of the top of the tube becoming, under certain ratings, 15 or more degrees hotter than the bottom. To produce arching, the steam insulating film would have to be superheated at the surface to a temperature something less than 15 deg., which is not so high as Mr. Sandstrom indicates.

Scale insulating the bottom of the tube and not the top, would expand the bottom and, as the bottom is initially longer than the top, it would cause it to sag to a greater extent. If Mr. Sandstrom's theory is correct, then steam locking has no effect and scale in the bottom is the only thing that causes tubes to arch. What, then, makes them sag? E. S. SMAIL.

Oak Park, Ill.

Accounting for Engineers

In an article in *Power* some time ago, it was stated that a prominent British engineer who visited the United States said, in a lecture on the education of engineers, that among men of his acquaintance and profession the lack of a knowledge of accounting was their greatest deficiency.

It has been suggested that young engineers study accounting during the summer vacations of their college years, if it is not included in their college courses, or study it in evening schools after they graduate. It is admited that accounting is distasteful to the average engineer. I had been engineering a long time before I had any use for accounting, then I had to go to night school and dig into it. It might come handy to a young engineer on his first job. If he wishes to learn the necessity for a knowledge of accounting, and learn it in an interesting way, the following should prove of interest.

Such firms as condensed-milk, dye, acid and chemical manufacturers, sugar and oil refiners, whose processes change with advancing knowledge and who are continually building and replacing, usually make specific appropriations from their treasuries to cover the costs of these changes, when the money required amounts to more than $500 or $1,000. This amount varies with different firms.

To get these appropriations, the plants have designs and estimates made, and a request is sent to the men who have the power to grant the appropriation. The request for the estimate may originate with the plant superintendent, general manager or chief engineer. The power to grant appropriations may be vested in the president, board of directors, manufacturing board or a specially appointed committee.

It is the function of the engineering department, more specifically some draftsman or estimator or supervising engineer, to draw up the plans, make the estimate and write the letter requesting that the appropriation be granted. In a small plant a young engineering graduate might do it all.

The estimator has to recommend to the accounting department how to charge the money. It is part and parcel of the estimate. The charge recommendations which we make at the plant where I am employed will serve as examples:

Plant account, which implies a direct increase in value to the plant, and is taxable.

Works expense, when some piece of apparatus is to be replaced by something which will do the same thing better or cheaper.

Maintenance, when some piece of apparatus has worn out and is to be replaced by an identical piece.

We make separate estimates for all dismantling. If the replacement is to be charged to works expense, the dismantling, plus depreciation less salvage credits, is charged to profit and loss. If the replacement is to be charged to maintenance, the dismantling, plus depreciation less salvage credits, is also charged to maintenance. Plant account items are generally new parts of plants, and there is seldom any dismantling necessary before building or installing them.

In asking for the appropriation, the estimator has to make a statement of savings or earnings, known as returns on the investment. He has to figure out interest on first cost, depreciation, maintenance, and any other fixed charges, and balance that against the savings or earnings and show the percentage of the returns.

To get into a job such as herein outlined, is an interesting way to learn accounting, since it can be learned in the plant by asking questions. At least it will provide a strong incentive for the young engineer to learn a little about the whys and wherefores of accounting. R. A. DICKSON.

Caldwell, N. J.

Sixty per Cent of Engineering Students Drop Out

Under the heading, "Sixty per Cent of Engineering Students Drop Out," in the Aug. 3 issue, appears an interesting communication from R. G. Fisher. I was particularly impressed by the last paragraph, in which he expresses his inability to suggest any means for reducing the number of men dropping out of the engineering profession.

There may be many reasons for this high rate of mortality, but there is one that I am sure is paramount, and that is, as far as college men are concerned, at least 90 per cent of the students enter college and 80 per cent of the graduates leave college without any reliable information as to the opportunities or lack of opportunities that exist in the engineering field.

This may appear to be a bold statement, but it is based upon a somewhat unique experience, and I am sure that I have understated rather than overstated the facts.

During the last few years I have had the privilege of interviewing about 150 applicants for membership in one of our leading engineering societies. A large percentage of them have been men under 30 years of age.

I invited these men to visit me as my guests, and most of them spent several hours with me discussing their plans, ambitions and difficulties, and I could not find that a single one of them had left college with what would appear to be adequate data upon which to base a decision as to his life's work.

It may not strike one as being significant when a young man asks you to give him, out of your wider

experience, some information or advice that might aid him in groping his way out of the darkness with which he is surrounded, nor does it when two or three have done so, but after 50 or 60 have asked for the same kind of help, you realize that you are facing a condition which has all the appearances of a first-class tragedy and which, in my opinion, is entirely unwarranted.

There is not a single man who has had even four or five years' experience in the engineering field, who has not gained some information as to the actual existing conditions, yet there is no mechanism through which this information can be collected and made available to our young graduates and undergraduates; or if there is, it is nearly 100 per cent inefficient, because they are not getting it.

There is not in existence, so far as I am aware, even a list of the different possible openings for young technical graduates with a description of the different kinds of work and their opportunities, yet millions of dollars are being spent every year for technical education, and the colleges are turning out thousands of men, for what? Apparently, to go out upon an uncharted sea, to sink or swim as fortune may favor them.

I do not think that the colleges should be blamed for this condition, but "someone has blundered," and I would place the responsibility upon the engineering profession as a whole.

Earlier in the year I presented a paper upon this subject before the American Society of Mechanical Engineers, a résumé of which was published in *Mechanical Engineering*. I have also discussed the matter with a large number of people, and seldom indeed has anyone failed to admit the seriousness of the conditions when the situation has been clearly called to his attention.

J. O. G. GIBBONS.

Newark, N. J.

Order of Opening and Closing Blowoff Valves

In their discussions on the "Order of Opening and Closing Blowoff Valves" in the April 27 and July 20 issues respectively, Prof. W. E. Grey and A. K. Vradenburgh both argue in favor of the same basic idea, yet seem to arrive at opposite conclusions. The basic idea is always to open the same valve first and to close last the valve first opened.

The purpose of installing two valves in a boiler blowoff line is safety and tightness. A valve that is opened fully in still water encounters practically no wiredrawing. To protect one of the two valves thus, assures one the tight one, depends upon the type of installation all valves must endure at the cracking point. If this severe service is always borne by the same valve, the unit of the two valves is preserved as a tight unit.

Whether it shall be the valve that is next to the boiler or the outside valve that is to be maintained as the tight one, depends upon the type of installation and the type of valves serving it. The preserving of a fixed sequence of operation is promoted when the two valves are of distinctly different types.

Then, too, a valve that quickly moves from cracked position to full open position is subject to wiredrawing for the minimum space of time. On the other hand, a quarter-turn valve increases the possibility of water hammer and shock unless intelligently controlled. These features argue in favor of the quarter-turn valve as the "stop valve" or "sealing valve." A screw-actuated valve in contrast to a quarter-turn valve, opens and closes more slowly and affords a more gradual control of the blowoff pressure and water, thus minimizing the possibility of water hammer and shock. Therefore the natural installation is a quarter-turn valve and a screw-actuated valve.

The first form of quarter-turn valve to be developed is the plug cock. The plug cock, when used in conjunction with a screw-actuated valve, may be placed either next to the boiler or outside of the screw-acuated valve. The sequence of operation should then be: Open plug cock first, open screw-actuated valve and blow; close screw-actuated valve, close plug cock. In such an installation the controlling factor of the sequence is not the position of the valve but its type.

The preferred position for a lever-operated quarter-turn valve, with the rotating disk held to its seat by a spring and thus forming a ground-joint sealing-face, is next to the boiler, with the screw-actuated valve beyond it. This is particularly so if more than one boiler discharges through a common blowoff header. In such an installation the correct sequence of operation is: Open valve next to the boiler first, open the outside valve and blow; close the outside valve, close valve next to the boiler.

Some types of boilers and some types of blowoff installations are served by two or more blowoff outlets entering a manifold, which manifold is served by a master valve. Practice places only one valve on each of the individual outlets. Here we have blowoff conditions that need special consideration. It might be possible to train a crew to open the valve on No. 1 outlet first, then open and shut the master valve on the manifold, then close the valve on No. 1 outlet and to repeat the process with each outlet, handling each outlet and the master valve as though an individual unit. However, that sounds like careful handling and too much labor. The trend is to open the master valve (the outside valve) first and then to open and close the valve controlling each outlet. Such a procedure tends to destroy the several valves on the several outlets and to preserve the master valve.

There is a third method, and perhaps it is the most practical one. Open the valve on outlet No. 1 before opening the master valve, open the master valve fully, open the valve on outlet No. 2, close the valve on outlet No. 1, open the valve on outlet No. 3, close the valve on outlet No. 2, close the master valve, close the valve on outlet No. 3. In other words, open the valve on the first outlet before opening the master valve and close the valve on the final outlet after closing the master valve.

Such multiple blowoff equipment may reduce the original investment in valves, but it assuredly destroys blowoff valves faster than does an equipment of two valves on each outlet, so that ultimate economy results if two valves are installed on each outlet, and, if desired, a master valve on the manifold, because valves are preserved and hot-water leaks are prevented.

Analyzed, the question becomes, not whether it is correct to open the inside valve first and the outside valve last, or the outside valve first and the inside valve last, but one of always maintaining the same sequence of operation for both valves so that one may be preserved and the other perform its function of added safety and blowing control. This fixed sequence may be positively predetermined by harnessing both valves under one control.

Jersey City, N. J.

Questions and Answers

Use of Cams

In what types of engines are cams used instead of eccentrics for valve-gear motion?

Steam engines using poppet valves have cams to lift the valves, but eccentrics are also used to actuate the cams. Internal-combustion engines almost universally make use of cams to open the several valves, springs being used to return the valves to the closed position.

Effect of Wear in Duplex Pump

If the bridge between the exhaust port and the steam port on a duplex pump becomes worn and leaks, what effect will this have on the working of the pump?

If the leak is not serious, the sole effect will be a loss of live steam through to the exhaust. If the exhaust line is restricted in some way, a serious leak at the bridge might cause the exhaust pressure to build up, with the result that the pressure on both piston faces would be equalized and the pump would stop.

Cold Storage of Furs

What system of cooling is most satisfactory for fur storage?

The low temperatures formerly advocated, such as 20 to 28 deg. F., are not necessary; 40 to 45 deg. is now considered as cold enough and, of course, cheaper than the lower temperature. Air-cooling coils in bunkers outside of the room proper, with forced circulation of the air, are preferred. With coils in the fur room the movement of air is too slow, particularly with coils on side walls, while with ceiling pipes the soiling due to dripping is difficult to prevent. The relative humidity required at 43 deg. should not exceed 2 grains of moisture per cubic foot, equivalent to 60 per cent humidity; this necessitates a pipe temperature of, say, 20 deg. F. and a back pressure of 20 pounds.

Injector Fails to Work

We have an injector which we use for feeding a boiler and which refuses to work. The injector will lift the water, but will not deliver it to the boiler. This persisted after the injector and hose were cleaned and inspected and the check valves examined. On the delivery line from the injector there are two check valves and an angle valve with a tee connection to be used in case of fire. Is it possible that our trouble is caused by too much resistance in this delivery pipe?

There are many little things that may prevent an injector from operating properly. When an injector lifts water but does not deliver it to the boiler, the trouble may be due to a leak in the suction line, water too hot, steam pressure too low, wet steam, nozzles of injectors clogged up and covered with scale, waste or overflow valves stuck or leaky, obstruction somewhere in the delivery pipe, or faulty boiler check valve. Your claim that there is too much resistance in the delivery pipe must be to some extent true. At least there is too much to permit the water to flow into the boiler. It is not meant by this that the resistance is necessarily any more than usual, but merely that it is too much for your injector working under present conditions.

Is the water coming to the injector sufficiently cold? An injector always works better with cold water. Sometimes it will start if you turn a cold hose on it. You have checked up and found that the injector and hose are clean, and that all the valves, including the check valve, work smoothly. Some time when the boiler is off the line, and all the pressure off, you might connect a hose onto the delivery line from the injector to the boiler and see if there is an unobstructed flow all the way into the boiler. There might be something blocking the flow beyond the last check valve.

The Effect of Speed Increase of Centrifugal Pumps

We have a centrifugal pump which operates at 200 r.p.m. and requires 100 hp. What will be the result if the speed is increased to 250 r.p.m.?

In considering centrifugal pumps three rules must be kept before one. These are: The head varies as the square of the speed; the quantity of water will vary as the speed; the power will vary as the cube of the speed.

For example, let it be assumed that the pump is now delivering water against 100 ft. head, of which 75 ft. represents the height from suction level to the end of the discharge pipe, and 25 ft. that consumed in friction in the pipe and fittings.

The quantity will vary as the speed, consequently if the pump handles 5,000 gal. per min. at 2000 r.p.m., at 250 r.p.m. the quantity pumped will be $\frac{250}{200} \times 5{,}000 =$ 6,250 gal. If the speed be increased from 200 to 250, the velocity of the water leaving the pump will be such that when converted into pressure head it will be different from that obtained with a speed of 200 r.p.m. The new head becomes

$$\left(\frac{250}{200}\right)^2 \times 100 = 156 + \text{ft.}$$

The frictional losses will vary approximately as the square of the quantities of water, which makes the new frictional head $\left(\frac{6{,}250}{5{,}000}\right)^2 \times 25 = 39 +$ ft. The total head resulting from the new speed has been found to be 156 ft. and if the pipe resistance is but 39 ft. and the static head 75 ft., or a total of 114 ft., a gate valve must be placed in the discharge pipe, which, by throttling will increase the frictional resistance by the equivalent of 156 — 114 = 42 ft. approx. On the assumption that the efficiency will remain constant, the horsepower at the new speed will be

$$\left(\frac{250}{200}\right)^3 \times 100 = 195 \text{ hp.}$$

If the amount of water pumped and the horsepower are undesirably high, the water output can be lowered by reducing the diameter of the impeller, and this reduces the frictional loss and the horsepower required.

New and Improved Equipment

Winton 800-Horsepower Diesel

Among the Diesel builders there is a marked tendency to raise the maximum horsepower rating. The Winton Engine Co. has in the past centered its activities upon the production of air-injection Diesels of low rating and gradually increased the range of engine sizes until at the present time it has entered the field of larger Diesels by building 800-hp. units. The illustrations show the general appearance of the Winton 800-hp., 300 r.p.m., four-stroke-cycle, air-injection engine, five of which have been installed on the yachts "Arcadia" and "Savarona" and the new dredge "Virginia."

The cylinders, of which there are six, have bores of 16¼ in., with a piston stroke of 22 in., and by reason of the piston speed the engine weighs less than 140 lb. per brake horsepower. A one-piece water-box construction, in which are inserted the cylinder liners, is used. The two-piece crankcase and water-box are held together by 16 steel tie-bolts from the bottom of the crankcase to the top of the water-box.

The 10½-in. crankshaft is made of open-hearth steel and is machined all over, the bearings and pins being ground. The bottom half of the crankcase carries the crankshaft in nine main bearings and extends aft to receive the thrust bearing base.

A one-piece casting, flanged and bolted to the top half of the crankcase makes up the water-box. Into this casting are inserted six charcoal-iron cylinder liners.

The cylinder heads are readily detachable without removing intake or exhaust manifolds. Each carries six removable valve cages, two for exhaust, two for intake, one for injection and one for air starting and relief valve. Exhaust and intake valves are identical and are provided with ample space for cooling water. A mushroom type of fuel-injection valve opening inwardly is used.

An unusual feature of the pistons is that they are made of Bu-Nite aluminum alloy. They are ground the full length and fitted with six compression rings and one oil scraper ring. The pin bearings are carried in the piston and the pin is clamped in the connecting rod.

Direct-connected to the engine at the forward end is the air compressor, which is driven from the main crankshaft. It is of the three-stage progressive type, fitted with easily removable valves, intercoolers between each stage and an aftercooler.

A six-plunger fuel pump has been adopted, and the fuel consumed by engine cylinders is metered by cutoff valves working during the suction strokes of pump plungers. This cutoff valve is regulated by the governor which controls the engine speed.

Trent Electrical Melting Pot

The portable electrically heated melting pot illustrated, is being made by Harold E. Trent, 259 North Lawrence St., Philadelphia. The unit, which is particularly designed for maintenance

Portable electric melting pot

work on babbitt-metal bearings, is adapted not only for ladle and dripping work, but also for pouring. The current supplied to the heating elements is controlled by a three-heat switch, and temperatures up to 1,000 deg. can be obtained. The pot operates on either alternating or direct-current.

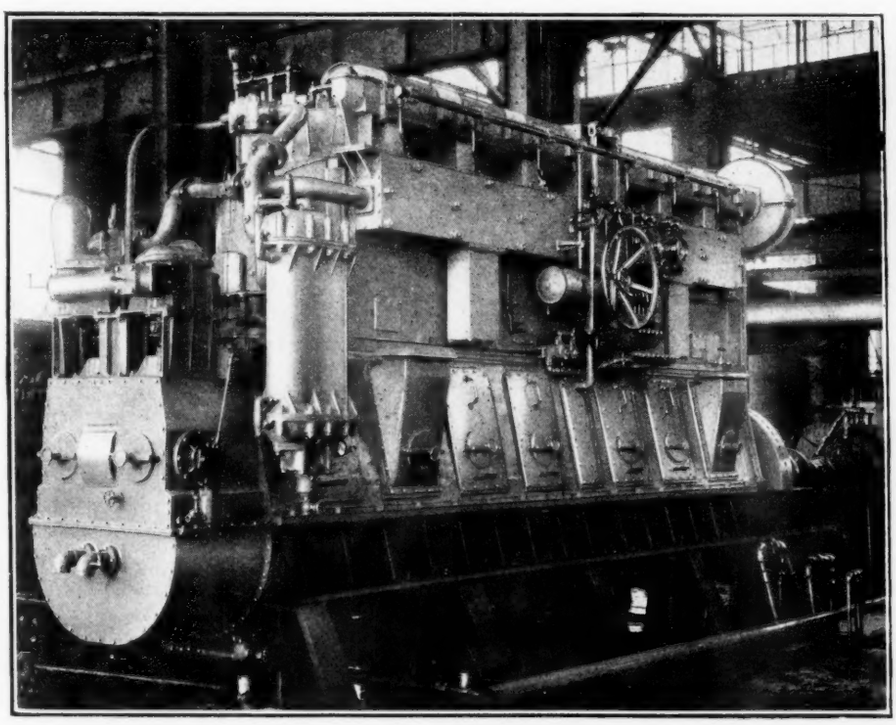


Fig. 1—Operating side of 800-hp. Winton Diesel

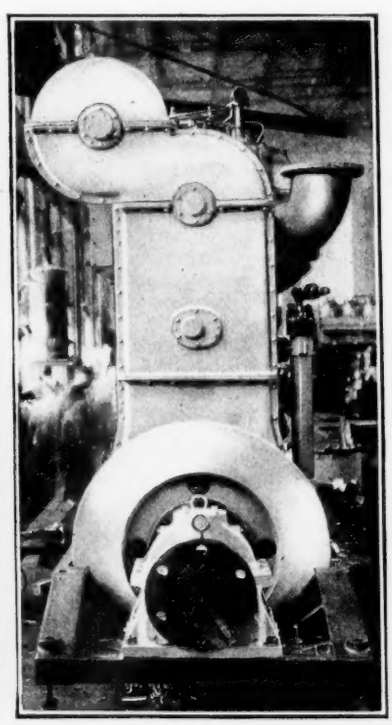


Fig. 2—End view of engine

Recent Publications

Controllers for Electric Motors. By Henry Duvall James. Published by D. Van Nostrand Co., 8 Warren St., New York City, 1926. Cloth; 6½x9 in.; 522 pages; 444 illustrations; 8 tables. Price, $5.

Of equal importance with the electric motor is the controller which makes the motor function in accordance with the demands of the particular application, which gives protection to the motor and provides those characteristics that are not inherent in the motor. In the early motor application the importance of the controller was not appreciated as it should have been. A great deal of attention was given to writing about the motor, but very little to the controller. Fortunately, during the last ten years electrical motor-control equipment is beginning to receive from technical authors the attention that its importance merits, of which this book is a good example.

The author in this, the second edition of his book, has brought together a mass of valuable material on electrical controllers for motors, which represents the accumulation of 25 years of experience in the design and application of controllers for all kinds of service. In revising, the material in the first edition has practcially all been rewritten and 12 new chapters have been added, so that the new edition is about double the size of the old. The object has been to bring together sufficient material on control to give a good general idea of its design and operation for the use of operating engineers, users of electrical apparatus and students. To this end the material has been presented from a number of different angles.

Such chapters as functions of control, how to make controller diagrams, how to read controller diagrams, and the chapter on the methods of acceleration deal with the fundamentals and give the reader an understanding of what control equipment is and how it functions. There are 17 chapters, each dealing with controllers for some specific industrial application of electric motors. Synchronous motors are rapidly coming into general use, and a chapter has been devoted to control equipment for these applications. Two other chapters of particular interest are those on the National Electrical Code and installation requirements, and protective devices. Two chapters have been devoted to elevator-control equipment.

Each chapter is preceded by a synopsis telling what it covers and at the end of each is a summary of the conclusions set forth. From this the reader can easily obtain the high points without reading the entire text. The division of starting resistor to obtain proper motor-acceleration characteristic is a problem there is no direct way of solving except where there are operating data available. The book contains a table that covers over 200 applications in 25 specific industries, which should be valuable to those who have these problems to deal with. The wide variety of subjects covered and the easily understood form in which they are presented, give to the book an extensive interest among those in any way interested in electric-motor controller problems.

Government Regulation of the Coal Industry. Compiled by Julia E. Johnson. Published by the H. W. Wilson Co., New York. Cloth; 5x7½ in.; 144 pages; Price, 90 cents.

This is No. 1 of Vol. 4 of The Reference Shelf series, consisting of reprints of selected articles, briefs, bibliographies, debates, and study outlines of timely topics, and is supplementary to a Handbook, Government Ownership of Coal Mines, by the same publishers.

The subject is defined by the following resolution:

RESOLVED: *That Federal legislation for regulating the coal industry should be adopted, based on the leading recommendations of the United States Coal Commission.*

This is followed by or is introductory to a brief setting forth the recommendations to be discussed, the issues involved, and lists of the topics to be considered in both the affirmative and the negative argument. Fourteen pages of bibliography are then given.

The text treatment is divided into 28 pages of General, 39 pages of Affirmative and 43 pages of Negative argument. The General Discussion consists of an excerpt from the 1925 Message of President Coolidge, urging action on the report of the Coal Commission; Recommendations of the Coal Commission, by Edward Eyre Hunt, secretary to the Commission; "Intervention and the Coal Situation," from *The Independent*, reviewing the action of various Presidents in relation to the coal supply; "Nationalization of Coal," a letter to Congress from the League for Industrial Democracy; "Coal Persists as a Gigantic Issue," from an article by Evans Clark in the *New York Times*.

In the Affirmative Discussion are presented two editorials from the *New York World*, "Truce in the Coal War" and "Is Coal to be Forgotten?" an article by Gov. George S. Silzer of New Jersey in *Current History Magazine* on "The President's Attitude Toward the Coal Crisis;" excerpts from an address by John L. Lewis, International President United Mine Workers of America; letter to the *New York Times*, by Ellis Searles, editor *United Mine Workers' Journal;* editorial from *New Republic*, "Coal, Mr. President;" and an excerpt from inaugural address of Gov. A. Harry Moore of New Jersey suggesting a Tri-State Board.

In the Negative are offered a Report and Resolutions submitted to the Chamber of Commerce of the State of New York by its Committee on Internal Trade and Improvements, opposing regulatory legislation; an article in the *Annalist*, by Murray T. Quigg, of New York Bar, on "Governor Pinchot and the Anthracite Monopoly;" a reply to Governor Silzer's "A Hack," by W. H. Woodin, president of the American Car & Foundry Co. and New York State Fuel Administrator in 1922; "Government in the Coal Business," from an address by Harry L. Gandy, executive secretary of the National Coal Association; "The Operators' Story," by George H. Cushing; "Case for Anthracite Coal," by S. D. Warriner, president of the Lehigh Coal & Navigation Co.; "Real Issue in the Coal Industry," from article by J. F. Calibreath, secretary American Mining Congress; "Coal Deadlock," from editorial in *New York Times;* "Government Ownership and Control of Coal," minutes Anthracite Coal Operators Conference.

The coal question would be a great deal easier to settle if every intelligent thinking man and woman would read and study this popular presentation of the issues involved and the claims made in their behalf by both sides.

Turbo-Blowers and Compressors. By W. J. Kearton, Lecturer in Engineering, the University of Liverpool. Published by Isaac Pitman & Sons, London and New York, 1926. Cloth; 6x8½ in.; 333 pages; profusely illustrated.

This is claimed to be the first work on this subject in English and it is a splendid beginning. The treatment is general and should prove of value to students, designers and engineers in charge of blowing and compressing equipment. While much of the matter in the book is original, the author acknowledges the assistance and cooperation of a number of European manufacturers of equipment who have furnished him with drawings and detailed information concerning their machinery.

The early chapters discuss the principles of operation of turbo-blowers and compressors, and the thermodynamic theory of air compression. This is done with a clarity and exactness quite above the average of much current technical literature. The volume continues with a discussion of governing and of various features of machine construction and operation, of stresses, critical speeds and similar topics of special interest to the designer. A chapter is devoted to testing and another to the development of performance characteristic curves. The illustrations, including a number of folding plates, are excellent, and the book is beautifully printed and well bound.

The performance of such machines is analyzed on a total heat-entropy chart for air in a manner entirely analogous to the use of the Mollier chart for steam in the analysis of steam-turbine performance, and this application to the study of gas compression is interesting and should prove distinctly helpful to the profession. The action of the turbo-compressor is analyzed in great detail, with the construction of velocity diagrams and performance curves for forward, backward and radial blades, and the discussion is skillfully composed, so that it is not only clear, but comparatively easy reading.

The volume is to be commended to all concerned with the use of such machinery.

News in the Field of Power

New York City Boiler Kills Three When Drum Breaks

A boiler explosion on Sept. 9 at the dyeing establishment of Rees & Rees, 232 East 40th St., New York City, killed the fireman, the coal passer and the assistant engineer, and slightly burned a truck driver.

The boiler, which was of the cross-drum sectional-header type, was carrying 110 lb. pressure, although a pressure of 125 lb. was allowed by the inspectors, when the rupture of the rear mud drum occurred. The fireman and coal passer were in the firing pit, which was about 5 ft. below the basement floor, and before they could escape, they were fatally burned by the rush of steam through the firedoors. The assistant engineer also was badly burned, subsequently dying at the hospital. The fourth man, a truck driver, was on the first floor immediately above the boiler and suffered burns from the steam passing up through the displaced floorboards.

Investigation by the boiler inspectors of the New York Police Department revealed that the explosion was due to a fracture on the under side of the mud drum. Examination showed that the sheet had wasted away by process of external corrosion. According to the police the boiler had been recently inspected without any trouble being revealed. The drum, however, was so placed that inspection of its under side was difficult.

Mississippi Central Power Chartered in Maryland

The Mississippi Central Power Corp. was chartered at Baltimore, Md., on Sept. 9, with a capitalization of 1,000,000 shares of no-par stock. The charter authorizes the company to engage in the production, distribution and storage of gas, water or steam, or power produced thereby; refrigeration of any kind; operate telephone, telegraph or radio stations; and operate any kind of interurban or city means of transportation.

No information as to the location of the company was available at the time of announcement. D. List Warner, Huntington Cairns and Leslie E. Mihn were named as incorporators, and Oswald L. Johnson, James B. Field and Percival E. Cowan as the board of directors.

Incorporation of the concern was said in Wall Street to be for the purpose of consolidating into a new group several Southern public utilities supervised by the Electric Bond & Share Co. The properties said to be involved in the transaction are controlled by the Electric Power & Light Corp., an Electric Bond & Share organization.

The Electric Power & Light properties which it is expected will be regrouped are the Arkansas Light & Power Co., Pine Bluff Co., Louisiana Power & Light Co., Central Louisiana Power Co., Louisiana Power Co. and the Mississippi Power & Light Company. These properties are already for the most part interconnected. They serve a population exceeding 300,000 persons and have book assets exceeding $35,000,000.

Electric Railway Men Will Discuss Power Problems

Power problems in the electric railway field are scheduled as the general subject of the Oct. 7 afternoon session of the engineering branch of the American Electric Railway Association which meets for its 45th annual convention Oct. 4-8 at Cleveland, Ohio.

In the form of committee reports, to be followed by discussions, "Power Generation and Conversion" will be presented by L. D. Bale, chairman, superintendent of power for the Cleveland Railway Co.; "Power Transmission and Distribution," by Charles H. Jones, chairman, general manager, Chicago, South Shore & South Bend R.R., Michigan City, Ind.; "Automatic Substations," by Adrian Hughes, Jr., United Railways & Electric Co., Balti- P. F. McCall, North Shore & Milwaukee Railroad Co., and a discussion on a proposed committee to co-operate with the United States Department of Commerce on the simplification and standardization. R. H. Dalgleish, chief engineer of the Capital Traction Co., Washington, D. C., will be the chairman on this subject.

The program of the convention is announced as closely as possible at this date. It is understood, however, that it is tentative and subject to alteration.

British Board of Trade Forms Fuel and Power Committee

In accordance with the recommendations of the Royal Commission on the Coal Industry the British Board of Trade announced late in August the appointment of the National Fuel and Power Committee.

This body is to consider and advise upon questions connected with the economic use of fuels and their conversion into energy, having regard to national and industrial requirements and in the light of technical developments. Sir Alfred Mond will head the committee as chairman. It is Sir Alfred's opinion that the regulated output of the industry is unquestionably necessary. He believes that at present Great Britian's normal output represents an over-production of about 15 per cent, and that this fact has led to the prevailing uneconomic situation. Unless production is regulated to suit consumption, England may, he argues, expect a continuation of alternate periods of boom and slump from which the coal industry has suffered for a long period and which are bad not only for that industry but also for all others.

Mechanical Engineers Told More Dignity Is Needed

Industrial trades must be given new dignity and made more attractive if boys of the right caliber are to be developed, said Harold S. Falk, of Milwaukee, Wis., in an address to members of the American Society of Mechanical Engineers, delivered at New Haven, Conn., Sept. 9.

Mr. Falk spoke at the technical session in connection with the Machine Tool Exhibition at Yale University.

"The machinist is as good a man as the bookkeeper and he gets as much pay. It remains to make him as highly respected a member of the community as the bookkeeper is," declared Mr. Falk. "Boys will not go into the trades until they and their parents feel that the work is just as desirable as is clerical work; until the molder and pattern molder are just as important in civic organizations and clubs—and in the eyes of young ladies too—as the bank clerk and the insurance office man."

The speaker explained that agencies which influence the public mind always idealize the man with the white collar and never the workingman and that even teachers threatened lazy pupils by telling them they would never be anything but mere workmen if they did not pay more attention to studies. He urged manufacturers to unite in advertising advantages of trade apprenticeship in their respective cities.

St. John River Development Passed by Commission

The application of the Saint John River Power Co., of Grand Falls, Province of New Brunswick, Canada, to construct and operate permanent works on the Saint John River in the vicinity of Grand Falls has been approved, W. H. Smith, secretary, the International Joint Commission, has just announced.

According to Secretary Smith, the project of the Saint John River Power Co. is practically the same as the development first proposed and later abandoned by the New Brunswick Electric Power Commission. The only practical difference between the two projects is that in the first the water was to be conducted to the wheels by means of a diversion canal, and in the second the plans provide for a pressure tunnel instead of an open waterway or canal, Mr. Smith explained.

The applicants contemplate an initial development of 30,000 hp., using the natural run-off of the watershed.

N.A.S.E. Convention Plans Activities To Meet Changing Conditions

Suggestion to Alter Constitution Includes New Name for Society—Large Fund for Educational Work Voted—Power Costs for Operating Men—Los Angeles for Next Meeting

THE Forty-Fourth Annual Convention of the National Association of Stationary Engineers, which was held last week in Atlantic City, gave evidence of a disposition on the part of the officers and delegates to adjust the activities of the organization to meet the changing conditions of the engineer.

This involved a number of proposed changes in the constitution. The most important of these was the suggestion to change the name to either "National Association of Power Engineers," or "National Association of Operating Engineers," the idea being that the word "stationary" is too limited and does not cover the present duties and interests of the membership. It was further proposed to refer to the National Board for action many matters which now have to come up in open convention. The suggestion was further made that a National Employment Bureau be established. In order for any of these to become effective, it was voted to place the proposed constitutional changes before the membership in an early referendum.

Votes $10,000 for Education

During the last year the "Merit" system has gone over strong, and in recognition of his excellent work as chairman of the Educational Committee, Frederick L. Ray was presented with a handsome silver cup by President Garrett Burgess, who was one of the pioneers and most active supporters of the system. A fund of ten thousand dollars was put aside for the use of the Educational Committee next year, and it was decided that a permanent full-time instructor be employed to handle he details of the work. N. K. Chamberlain, of Detroit, graduate of the University of Michigan, and a power engineer for the Telluride Power Co. and the United States Rubber Co., was chosen educational director.

Although there was no general technical program this year, two instructive talks on engineering subjects were given. One was by Henry Kreisinger of the Combustion Engineering Corp., who delivered a lecture on "Pulverized Coal Combustion" and described the new Combustion steam generator. The second was by R. P. Tobin of the Vacuum Oil Company, who in a thoroughly practical talk on "Lubrication" explained the requirements for various types of prime movers, and discussed the design of bearings to meet different conditions of pressure and speed.

Reports Power Production Costs

The Power Plant Costs Committee brought in a comprehensive report aimed at helping the operating man in appraising his power production costs. In a simple, but thorough manner, it explains the necessity for various fixed charges, and shows how to figure them. and also takes up all items that should enter into the operating costs. Moreover, the report shows how to interpret rates for purchased electricity, to analyze an electrical power bill, and to make intelligent comparisons with all factors considered. Actual curves and figures taken from typical plants are included. This report is one that should be in the hands of every operating engineer.

The usual line of exhibits was in evidence, and the arrangement of booths on the Steel Pier afforded an excellent opportunity for inspection of the products. Two of the exhibitors, namely, Jenkins Bros. and C. E. Squires, introduced an innovation, carrying personal interest to many delegates, in the form of moving pictures taken of delegates on the boardwalk and elsewhere. These were immediately reproduced and exhibited continuously during the convention. Each of these companies has announced its willingness to make these reels available for the use of any local association whose members might care to see something of the Atlantic City meeting.

Social features of the convention included an informal reception by the National Officers at the Strand Hotel on Monday evening, a smoker on Wednesday evening at the Casino and the annual ball and installation of officers on Friday evening.

The officers elected for the coming year were as follows:

John Quincy Adams, president; Elmer L. Bassett, vice-president; Tom Clark, of Worcester, Mass., conductor; Joseph Flynn, doorkeeper, and Joseph O'Connell, new member of the board of trustees. Sam Force and Fred Raven were re-elected treasurer and secretary.

The new officers of the National Exhibitors' Association are: George R. Rowland, Texas Co., president; Jacob Eige, Fisher Governor Co., vice-president; Thomas F. Boyle, D. T. Williams Valve Co., treasurer. The executive committee consist of I. S. Pieters, Plibrico Jointless Fire Brick Co., chairman; George T. Ogden, C. E. Squires Co.; John H. Allen, the Everlasting Valve Co.; John Throesher, John Roeblings Sons, and H. A. Burdorf, Lukenheimer Company. Appointed to serve as secretary of the year 1926, F. N. Chapman, A. Leschen & Sons Rope Co., 5909 Kennerly Avenue, St. Louis, Mo.

The 1927 convention will be held at Los Angeles in September.

Detroit Edison Plans Series of Boiler Unit Tests

During the next few months The Detroit Edison Co., according to a recent issue of the *Synchroscope*, plans to conduct a series of tests on one of the large boiler units at the Trenton Channel plant. This is a W-Type Stirling boiler, with air-cooled furnace walls and a water-tube screen over the hearth, fired by pulverized coal. The tests will, of course, include the superheater and economizer.

The tests will comprise runs in order to determine the operating characteristics of the boiler unit with different ratios of primary to secondary air supply, with special burners to allow addi-

This year's convention of the N.A.S.E. enjoyed Atlantic City's boardwalk more than ever. Here is a "long shot"

tional air to be forced into the burners and burner casings in excess of the amount now admitted (this air quantity will be termed tertiary air), with different degrees of pulverization of the coal, with different methods of banking and flue blowing, with variable loads, and with different grades of coal.

Pulverized coal will be weighed in a pair of special hoppers and will be fed to the boiler under test by a separate pump. The water weights will be determined by weighing tanks permanently installed for use in connection with boiler tests and turbine steam rate tests. The boiler will be isolated from its neighbors with respect to feed water and fuel supply.

PLANS CAREFUL AND COMPLETE

Thermocouples will be used to measure flue-gas temperatures at 32 points in the boiler and economizer and drafts will be measured at the same points. Flue-gas samples will be drawn from 22 points. The quantity of primary air will be estimated by discharging steam into the fan suction pipe at a known rate, and observing the humidity of the air before and after the admission of steam. Samples of flue gas with its suspended dust will be secured from eight points. The dust will be caught in a separator or collector and the gas quantity will be estimated by means of a norifice meter. The dust will be weighed and analyzed for combustible content.

The plans for the test are very complete, and detailed information will be secured on a large variety of subjects. The magnitude of the undertaking will be evident from the fact that 25 men are required on each shift for the conduct of the test, making a total of 75 men assigned to the immediate duties involved in such an undertaking. In addition to this, several men will naturally give much attention to supervision of the work and the interpretation of results in progress.

The results of this series of tests will be reported to the A.S.M.E., and the power industry will await eagerly this report, which will be particularly interesting in comparison with the report on a similar series of tests of a stoker-fired boiler at the Connors Creek Mine, some five or six years ago.

Metropolitan-Edison Adds to Susquehanna Station

An additional supply of electricity, sufficient to meet the normal light and power requirements of a city of 100,000 inhabitants, was recently made available for use throughout the territory of the Pennsylvania-New Jersey Power System, when a new 35,000-kw. steam turbo-generator was put into operation at the Susquehanna River station of the Metropolitan Edison Co., at Middletown, Pa.

The new generating unit more than doubles the former capacity of the Susquehanna station, the initial unit which was placed in service about eighteen months ago, having an output of 30,000 kw. With both units in operation the station has a capacity of 65,000 kw. If required, however, the two units can easily produce 70,000 kilowatts.

Giant Frequency Changer for So. California Edison

A synchronous frequency changer set to form a tie between a 50- to 60-cycle system, which will cost $250,000, will shortly be built by the Westinghouse Electric & Manufacturing Co. for the Southern California Edison Co.

This set will be rated at 30,000 kva. and will operate at 600 r.p.m. It will be equipped with two direct-connected exciters, two air coolers, starting autotransformers and regulating equipment. The machine is to be installed in the Rector substation, and will receive power from the Big Creek generating plants at 50 cycles, converting it to 60 cycles for use in the San Joaquin Valley.

Oil Engines Course Reopens at Brooklyn Polytechnic

The third yearly course on Diesel and oil engines at the Polytechnic Institute, Brooklyn, N. Y., is announced for opening Oct. 1.

Twenty two-hour lectures are to be given on Friday nights at 99 Livingston St., Brooklyn. As was the case last year, the lectures will be supplemented by class-room exercises and laboratory work. Julius Kuttner, who delivered the lectures in previous years, will again be in charge.

No detailed survey of every existing type and kind of oil engine mechanism is attempted; effort, on the other hand, is centered on drilling fundamentals so thoroughly that the student should have no difficulty in dealing effectively with whatever special oil engine problem he may later be confronted with. Laboratory work performed in connection with the single-cylinder Diesel engine available at the Institute carries out the general scheme of demonstrating fundamentals to the students, who are assembled fortnightly in small groups for this purpose. The engine is assembled, dismounted, adjusted, and tested under power with a view to giving graphic illustrations to the points made in the course of the lectures.

Students may enroll either for the series of lectures alone, one evening a week, or for lectures, class room and laboratory, two evenings a week. Those who enroll for the entire course and who make a satisfactory record as regards attendance and proficiency, are awarded a certificate to that effect at the end of the course. Students may attend the first two lectures, October 1 and 8, without obligation, registrations being accepted by Professor Church, Polytechnic Institute, 99 Livingston St., Brooklyn.

"Scenic Beauty" Is Argument Against Another Project

Alleged marring of scenic beauty has been employed so successfully in delaying water-power development that it is becoming the standard specific used by the opponents of such projects.

The latest instance in which "beauty" has been dragged in by the heels is in connection with the application by the Wisconsin Power & Light Co. for rights on the Wolf River. The proposed reservoir encroaches upon a few acres of the Menonomee Indian reservation. Representations now are being made that this constitutes one of nature's garden spots.

Protests against the project of the Cumberland Hydro-Electric Co., at Cumberland Falls, continue to reach Washington.

of the delegates and their ladies, attending supply men, and visitors, proving that a big time was had by all

Increased Power a Factor in Smaller Coal Exports

The increased hydro-electric development, consumption of fuel oil, and increasing coal production of countries which were formerly importers have very adversely affected the coal exports of the three leading coal-producing countries, the United Kingdom, United States and Germany, according to the Minerals Division of the Department of Commerce.

In 1913 German exports of bituminous coal amounted to more than 34,000,000 metric tons, which had declined to less than 14,000,000 in 1925. The United Kingdom during the last prewar year exported more than 73,000,000 long tons of hard and soft coal, while in 1925 the figure was under 51,000,000. The United States is said to show the smallest decline of the three countries, the figures being approximately 21,000,000 long tons of hard and soft coal in 1913 and a trifle less than 19,000,000 in 1925.

Westinghouse Advances Five Engineers in Department

Reorganization of the general engineering department of the Westinghouse Electric & Manufacturing Co. has been announced by H. W. Cope, assistant director of engineering.

The reorganization has necessitated the re-allocation of several engineers, four being elevated to managers of engineering. These are F. C. Hanker, manager of central station engineering; S. B. Cooper, manager of railway engineering; G. E. Stoltz, manager of industrial engineering, and W. E. Thau, manager of marine engineering. S. A. Staege, formerly section engineer in charge of the paper-mill section, has been appointed industrial engineer giving particular attention to the paper-mill industry.

Tallahassee Power Builds Large Dam

The Tallahassee Power Co. began on Sept. 2 to construct at Badin, N. C., a dam which will cost several million dollars, which will be used to produce hydro-electric power for public service plants, it was announced by Frank D. Grist, state commissioner of labor and printing.

The dam also will be used, it is said, to provide a water supply during the dry season for the plant of the Aluminum Co. of America at Badin.

Commissioner Grist estimated that the cost of the project would run between $12,000,000 and $15,000,000.

Southeastern Power Buys Rome (Ga.) Plant

Acquisition of the Rome Railway & Light Co. by the Southeastern Power & Light Co. became effective Sept. 1. The announcement was made by P. S. Arkwright, president of the Georgia Railway & Power Co.

The effect of the acquisition of the Rome company is to extend the merger of public utility properties in Georgia, which has been in progress since the first of the year and which has already brought into one system controlled by the Southeastern company approximately 140 cities and towns, including Atlanta, Macon, Athens, Brunswick, Milledgeville, Dublin and others.

Leading German Electric Firms About To Merge

It is rumored that the three leading German electrical firms, the A.E.G. Siemens Halske, and the Bergmann Co., are about to amalgamate.

These firms practically monopolize the home market, and also play an important rôle in the international market, being behind many subsidiary companies in various European countries. Competition among themselves has already been mitigated by agreements concerning several branches of industrial activity, and they have participated in the constitution of the Oram Co., which is associated with the International Electric Bulb combine.

New Zealand Shows Growth in Water Power

Hydro-electric development in New Zealand is increasing each year. In 1925 there was about 70,150 hp. of water energy in use, divided as follows: electric supply for lighting and domestic uses, 59,993; mines, 3,334; freezing works, 1,236; dairies, 1,227; paper mills, 450; flour mills, 310; sawmills, 296; flax mills, 207; construction works, 94; and miscellaneous, 2,997. There are 31 hydro-electric installations distributing power, of which 23 are operated by local authorities, 3 by the State, and 5 by private enterprises. New Zealand still has considerable undeveloped water power.

Early Development of India's Potential Power Seen

Hydro-electric projects at Mysore and Bombay have increased interest in various parts of India regarding greater development of power, states a report made public by the Department of Commerce.

Survey of the Punjab and the adjoining native states has disclosed a potential supply of nearly 2,500,000 hp., most of which is capable of economical development. The official program outlined for the Punjab foreshadows the ultimate completion of a system of electric power transmission lines extending from Peshawar in the northwestern part of India to Delhi.

Generator and Motor Sales To Italy Grow

Greatest increase in Italian imports of electrical goods in 1925 was in the receipts of generators and motors which rose from 17,000 quintals in 1924 to 24,000 quintals in 1925, according to the Electrical Equipment Division of the Department of Commerce.

Penn-Ohio Power's Output Shows Rapid Growth

The Penn-Ohio Power Co., which is controlled by the Republic Railway & Light Co. and the Penn-Ohio Securities Corp., established a record electrical output of 43,500,244 kw.-hr. in August, an increase of 36.5 per cent over August, 1925. Output in the year ended Aug. 31 was 481,155,031 kw.-hr., an increase of 30 per cent over the previous year.

Obituary

Dr. George I. Alden, one of the most distinguished mechanical engineers in New England, founder and chairman of the board of the Norton Co., Worcester, Mass., and for twenty-eight years head of the department of mechanical engineering in the Worcester Polytechnic Institute, died at his summer home in Princeton, Mass., Sept. 13, at the age of eighty-three. Dr. Alden was a native of Templeton, Mass., and was a graduate of the Lawrence Scientific School of Harvard University. He served for two periods as acting president of the Polytechnic Institute, and was the inventor of the well-known Alden absorption dynamometer.

Personal Mention

R. D. Evans has been appointed engineer in the transmission engineering department of the Westinghouse Electric & Manufacturing Co.

C. A. Powel has been assigned to the central station engineering department of the Westinghouse Electric & Manufacturing Co. as engineer in the generating station division.

Joseph Hecking has left the service of the American Bureau of Shipping, and Sidney K. Smith has been appointed to succeed him as a member of the American Marine Standards Committee.

C. A. Butcher, as announced by H. W. Cope, assistant director of engineering, Westinghouse Electric & Manufacturing Co., has been appointed engineer in the substation engineering division of the company.

Beekman C. Little, charter member R.E.S., superintendent of the Rochester Waterworks system for 35 years, has resigned that position to devote his full time to the secretaryship of the American Waterworks Association.

Major J. W. D. Cook has vacated the position of resident manager for Newcombe-Hawley, Inc., St. Charles, Ill., and has taken a position with Fairbanks-Morse & Co. at the Sheffield Works, Three Rivers, Mich., as assistant works manager.

J. M. Herrington, of the School of Mechanical Engineering of the University of Oklahoma, has been appointed to fill the place in the Vanderbilt School of Engineering left vacant by the death of Dr. C. S. Brown. Professor Herrington, whose present home is in Stillwater, Oklahoma, is a graduate of Mississippi A. & M. College and holds the degree of Master of Engineering from Texas A. & M. College. He will serve as supply professor under Dean W. H. Schuerman, of the School of Mechanical Engineering.

C. H. Johnson has been appointed engineer, service department, of the Timken Roller Bearing Co. He will have direct charge of the installation of Timken bearings in industrial applications.

F. C. Evans, assistant professor of heat power engineering, Sibley College, Cornell University, who has been putting in part of the summer as a member of the *Power* Editorial Staff, has returned to Ithaca, N. Y.

Business Notes

The California-Oregon Power Co. has announced that Paul B. McKee, who has been vice-president and general manager since 1914, with headquarters in Medford, Oregon, has resigned that position and will move soon to San Francisco. A successor has not yet been named, but it is expected the position will be filled within a month.

The Roller-Smith Co., 233 Broadway, New York City, announces the appointment of the following new agents: the Robinson Sales Co., Polson Bldg., Seattle, Washington, for the State of Washington and most of Oregon, and the Ashida Engineering Co., Ltd., Daini, Osaka, Japan, for Japan, Korea and Manchuria.

The Graybar Electric Co. announces change in management of its Providence, R. I. and Grand Rapids, Mich. distributing branches, effective Sept. 1. A. Schwenck, sales manager at Grand Rapids, will assume the managership of the Providence branch, while Frank Caestecker, of the Chicago branch, will assume the managership duties at Grand Rapids.

Trade Catalogs

Skip-lift for Bulk Materials—R. H. Beaumont Co., Philadelphia, in Bulletin No. 79, describes the Beaumont Skip-lift for handling bulk materials. There are three methods of operation, the full-automatic, semi-automatic and manually operated types. Both coal and ashes can readily be handled by this machine. Coal is elevated entirely automatically without the services of an attendant; the workman who brings the ash from the hoppers controls the operation when the ashes are handled. Coke, sand, gravel, stone and other granular materials can be handled cheaply, quickly and reliably.

Direct and Alternating Current Instruments—The Roller-Smith Co., manufacturer of electrical measuring and protective apparatus, 233 Broadway, New York City, has printed new Bulletins Nos. 110 and 150 covering, respectively, new types HTD and HTA instruments. Bulletin 110, listing HTD instruments, covers direct-current ammeters, voltmeters, and volt-ammeters. The HTA instruments, in Bulletin 150, comprise alternating-current ammeters, voltmeters and single-phase wattmeters. Features claimed for both types of instruments include very small size, accuracy for ordinary tests, light weight, and completeness of line.

Recording Voltmeters—The Bristol Co., manufacturer of Bristol's recording instruments, Waterbury, Conn. The new electrical catalog of the company, No. 1502, devoted to recording voltmeters is replete with diagrams and illustrations of many models. Reproductions of round and strip charts are given. An inserted leaflet of prices and special instructions is also included.

Motor Starting Oil Circuit-Breakers.—Leaflet No. 20,292 has recently been released by the Westinghouse Electric & Manufacturing Co. describing the type MF motor starting oil circuit-breakers. Such features as the manual operation, indoor service, non-automatic starting position, and the automatic running position are pointed out, and the application, operation, construction and engineer's specifications are discussed. Two tables, one showing the ratings for motor starting breakers, and the other listing the motor starting breakers of the type MF complete this leaflet which may be had at any of the district offices of the Westinghouse company or at the publicity department at East Pittsburgh, Pa.

Centrifugal Pumps Handling Oils—Goulds Pumps, Inc., manufacturers of centrifugal pumps, Seneca Falls, N. Y., has issued as Bulletin No. 130, "A Further Investigation of the Performance of Centrifugal Pumps When Pumping Oils," a report by Robert L. Daugherty, professor of mechanical and hydraulic engineering at California Institute of Technology, which gives the results of some extensive tests that the company announces as having just been completed.

These experiments dealt specifically with the effect of viscosity and vapor pressure, and prompted the series of tests under discussion, to determine the effect of pump size with the object of discovering if a specially designed pump would show a higher efficiency when handling oil than does a standard water pump. The author makes use of the early part of the report to outline the several recognized factors influencing pump operation and to describe the test apparatus. He reaches the conclusion that a centrifugal pump to handle oil should be designed in a different manner from one for water. In the appendix are given a set of charts covering the test results.

Coming Conventions

American Electric Railway Engineering Association. Annual Meeting at Cleveland, Ohio, Oct. 4-8. Papers in power field Oct. 7. J. W. Welsh, 292 Madison Ave., New York City.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Richmond, Va., Sept. 27-30.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman. First International Welding Exposition will be held in conjunction with meeting.

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Divisional meetings on the following dates: New England Division at Poland Spring House, Poland, Me., Sept. 20-23; Miss O. A. Bursiel, secretary, 149 Tremont St., Boston, Mass. Great Lakes Division at French Lick, Ind., Sept. 23-25; R. V. Prather, secretary, 205 Illinois Mine Workers' Bldg., Springfield, Ill. Kansas Section at Manhattan, Kan., Oct. 14-16; H. Lee Jones, secretary, 401 National Reserve Bldg., Topeka, Kan.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Sept 9 1926
Pool 1	New York	$2.40@$2.75
Smokeless	Boston	2.59
Clearfield	Boston	1.75@ 2.00
Somerset	Boston	1.85@ 2.10
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.10
Pittsburgh gas slack	Pittsburgh	1.20@ 1.25
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.10@ 1.35
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	1.85@ 2.75
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Sept. 16, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Sept. 13, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.20 per bbl.; 26@28 deg., $2.25 per bbl.; 28@30 deg., $2.30 per bbl.; 30@32 deg., $2.35 per bbl.; 32@36 deg., gas oil, 6.25c. per gal.; 38@40 deg., 7½c. per gal.

Pittsburgh—Sept. 7, f.o.b. local refinery; 30@34 deg., fuel oil, 5.87½c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—Sept. 15, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—Sept. 15, 27@30 deg. $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati—Sept. 15, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Sept. 13, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1,45@$1.50 per bbl.; 26@30 deg., $1.60@$1.65; 30@32 deg., $1.80.

Boston—Sept. 13, tank-car lots f.o.b. 12@14 deg. Baumé 4.75c. per gal.; 28@32 deg., 6c. per gal.

New Plant Construction

Ark., Marianna—Marianna Ice & Storage Co., is having plans prepared for improving ice plant, here. Estimated cost $30,000. J. R. Tate & Sons, St. Louis, Mo., are engineers.

Calif., Long Beach—Medical Research Institute is having preliminary plans prepared for the construction of research institute buildings, including power house, etc. Estimated cost $5,000,000. H. D. Frankfurt Co., 1096 North Western Ave., Los Angeles, is architect.

Fla., Tampa—Publix Treatre Corp., 16 East 42nd St., New York City, plans the construction of 16 story, office and theatre building with 4 electric elevators, on Tampa St. Estimated cost $1,000,000.

Ga., Macon—City plans the purchase of 10 m.g. centrifugal pump, etc., for waterworks. Estimated cost $60,000.

Ga., Wayeross—Ware County Light & Power Co. plans the construction of 150 ton daily capacity electrically operated ice plant. Estimated cost $100,000.

Ill., Chicago—City, Dept. Public Works, City Hall, will receive bids until September 24, for furnishing and erecting one 300 hp. water tube boiler and 1 mechanical stoker at the Stony Island Avenue Pumping Station, 73rd St. and Stony Ave. A. A. Sprague is commissioner.

Ill., Chicago—M. Eller, clerk of Sanitary District of Chicago, 910 South Michigan Ave. will receive bids until October 14, for North Side Sewage Treatment Works, Div. U.; constructing service building, and installing electrical and mechanical equipment, Howard St., Niles Center.

Ill., Chicago—A. L. Farwell, 1301 Ritchie Court, is having plans prepared for the construction of 9 story, store and office building, with 2 elevators, at Michigan Blvd. and Erie St. Estimated cost $1,000,000. P. Maher, 157 East Erie St., is architect.

Ill., Chicago—South Shore Building Enterprise Syndicate, c/o H. K. Holsman, 307 North Michigan Ave. Archt. will soon receive bids for the construction of 16 story apartment, with 1 freight and 2 passenger elevators, refrigeration plant, etc. on East 67th St. near Cranden Ave. Estimated cost $1,250,000.

Ill., Granite City—St. Elizabeths Hospital c/o Sister Superior, will receive bids in October for the construction of 4 story hospital on Madison Ave. Estimated cost $500,000. V. J. Klutho, Syndicate Trust Bldg., is architect.

Ill., Springfield—City Water Works will soon award contract for foundation for steam generator at waterworks plant. $11,685. Burns & McDonnell Engineering Co., 40 Interstate Bldg., Kansas City, Mo., is engineer.

Ind., Indianapolis—T. A. Moynahan, 320 North Meridan St. is having plans prepared for the construction of apartment house at 3033-35 North Meridan St. Estimated cost $1,000,000. Private plans.

Ia., Davenport—American Commercial & Savings Bank, 230 Main St., will receive bids about December 15 for the construction of 14 story bank and office building at 3rd and Main Sts. Estimated cost $1,500,000. Weary & Alford Co., 1923 Calumet Ave., Chicago, Ill., are architects.

La., Franklin—City will receive bids until September 28, for booster pumping station, filtration plant, fire pump, etc. Estimated cost $150,000. H. A. Mentz, Citizens Bank Bldg., Hammond, is engineer.

Mass., Boston—Y.M.C.A., 316 Huntington Ave. plans hotel, here. Estimated cost $1,000,000. Engineer and architect not selected. R. S. Johnson is president.

Mass., Fitchburg — Burbank Hospital, Nichols St. awarded contract for the construction of hospital and power house to T. A. Cassidy, 54 Boylston St., $208,500.

Mass., Gloucester—City, c/o Fay, Spofford & Thorndike, 44 Bromfield St., Archts, Boston, is having plans prepared for the construction of pumping station, here. Estimated cost $50,000.

Mich., Detroit — Department of Water Supply, G. H. Fenkell, Genl. Mgr., 176 East Jefferson Ave., will receive bids until October 6 for two 5,000 g.p.m. electric motor driven centrifugal pumping units for booster station in Linwood and Fenkell Aves.

Mich., Detroit — Electric Refrigeration Corp., awarded general contract for the construction of factory, office building, power house, etc., on Pennsylvania Ave. to W. E. Wood Co., 1805 Ford Bldg. This corrects report in September 6 issue.

Mo., Kansas City—Midland Investment Co., c/o T. W. Lamb, 644 8th Ave., New York City, Archt., awarded contract for the construction of 12 story office, stores and theatre building at 13th and Main Sts., here, to Boaz Kiel Constr. Co., 7th and Locust Sts. Estimated cost $3,800,000. Three electric elevators will be installed.

Mo., Kansas City—City Ice Co., 21st and Campbell St. plans the construction of addition to ice plant, including electrical equipment, at 4826 Oak St. Private plans.

Mo., St. Louis—Board of Public Service, J. Pritchard, Dir. will receive bids until October 26, for 2 high pressure steam driven centrifugal pumps, 30 to 35 m.g. each; 2 low pressure 40 to 60 m.g. each; and 1 low pressure pump of 60 to 120 m.g. per day. Estimated cost $600,000.

Mo., St. Louis—R. C. Stanhope, Jr., 418 Security Bldg., is in the market for 25 hp. boiler and derrick.

Mo., St. Louis—J. Rulin, 808 Chestnut St. will soon receive bids for the construction of an 8 story, apartment, on West Pine St. at Newstead Ave. Estimated cost $500,000. N. B. Howard and M. C. Finley, International Life Bldg., are architects.

Neb., Grand Island—City, H. E. Clifford, Clk. plans the construction of extensions to electric light and power plant, including additional power building, installing steam turbine unit, switchboard, etc. Estimated most $150,000. Pillsbury Engineering Co., 2344 Nicollet Ave., Minneapolis, Minn., is engineer.

Neb., Omaha—Allen Filter Service Co., 407 Karbach Bldg., plans the construction of 2 story ice plant. Estimated cost $75,000. Private plans.

N. J., Newark—Department of Parks and Public Safety, City Hall will receive bids until September 27, for construction of power house, in connecting with extensions to city hall. Estimated cost $200,000. J. S. Pigott, 402 Broad St. is architect.

N. Y., Brooklyn—Lutheran Hospital, East New York Ave., will soon receive bids for the construction of 4 story service building and power house, on East New York Ave. Estimated cost $700,000. R. Resler, 41 East 42nd St. is architect.

N. Y., Brooklyn—Owner c/o Slee & Bryson, 154 Montgomery St., Archts. is having plans prepared for the construction of 10 story office building with 3 electric elevators, at 140 Remsen St. Estimated cost $1,000,000.

N. Y., Middle Village—Metropolitan Recourses, 111 Bway., New York City is having plans prepared for the construction of power house, here. Estimated cost $250,000. Lockwood Greene & Co., 100 East 42nd St., New York City, is engineer.

N. Y., New York—W. A. Harriman, 39 Bway., is having plans prepared for the construction of 35 story office building at 35 Bway. Estimated cost $5,000,000. Cross & Cross, 385 Madison Ave., are architects.

N. Y., New York—Reconstruction Hospital, 395 Central Park West, E. Gidding, Supt., plans the construction of 14 story, hospital addition, with 3 electric elevators at Central Park West and 100th St. Estimated cost $1,000,000. Engineer and architect not selected.

N. Y., New York—Twenty-Eight East 52nd St. Corp., 238 William St., A. Brisbane, Pres. is having plans prepared for the construction of 28 story, 100 x 125 ft. office building, with 5 electric elevators, at 481 Madison Ave. Estimated cost $1,650,000. Rouse & Goldstone, 512 5th Ave. are engineers and architects.

N. Y., New York—C. S. White, Purch. Agt. New York Central R.R. Co., 466 Lexington Ave. will receive bids until September 24 for furnishing and erecting synchonous converters, air blast transformers, etc.

N. Y., St. George—Staten Island Edison Corp., 40 Bay St., authorized addition of 15,000 kw. turbine, with boilers and auxiliary equipment, in Livingston Plant. Estimated cost $1,340,000. J. G. White Management Co., 33 Liberty St., New York City, is engineer. Equipment will be installed by Westinghouse Electric & Manufacturing Co., 150 Bway., New York City.

N. C., Sanford—Bd. Alderman, plans surveys for constructing dam and pumping station, on Little River to increase city water supply by 1 m.g. per day.

O., Hamilton—Community Hotel c/o F. G. Mueller and W. R. Hair, Archts., Tentschzler Bldg., awarded contract for the construction of 7 story hotel, with 1 freight and 3 passenger elevators, at Monument Ave. and High St. to F. K. Vaughn Bldg. Co., Hamilton, $229,553.

Okla., Bushyhead—City is having preliminary plans prepared for constructing waterworks, including deep well pump. Estimated cost $18,000. Gant-Baker Co., 1116 West Main St., Oklahoma City is engineer.

Okla., Chelsea—City is having preliminary plans prepared for impounding reservoir, filter and pumping equipment. Estimated cost $60,000. Engineer not announced. H. T. Corwin is mayor.

Okla., Chickasha—Carter Oil Co., Chickasha, is having plans prepared for the construction of waterworks, including pumping station, pumping equipment, etc. Estimated cost $150,000. Private plans.

Okla., Coweta—City is having plans prepared for the construction of extensions to waterworks including deep well pump and motor. Estimated cost $20,000. W. E. Davis, Cole Bldg., Tulsa, is engineer.

Okla., Yale—City is having preliminary plans prepared water supply system, including deep well pumping equipment. Estimated cost $40,000. L. S. Garrison, Yale, is engineer.

Pa., Pittsburgh — Roosevelt Hotel Co. awarded contract for the construction of 13 story hotel addition at 6th St. and Pennsylvania Ave. to Landon Bros. Construction Co., 125 1st Ave.

Tenn., Nashville—City awarded contract for construction of boiler and power plant, here to Foster & Creighton Co., 4th and 1st National Bank Bldg., $67,900.

Tex., Baird—City, J. R. Black, Mayor, will soon award contract for the construction of waterworks improvements, including pumping equipment. Estimated cost $55,000. Kock & Fowler, 801 Central Bank Bldg., Dallas, are engineers.

Tex., Lorenzo—Voted $42,000 bonds for waterworks improvements, including deep well pump, etc. Montgomery & Ward, City National Bank Bldg., Wichita Falls, are engineers.

Tex., San Antonio—P and S Hospital, c/o J. H. Cunningham, 111 Dallas St. is having preliminary plans prepared for the construction of 4 story hospital, with 3 elevators, at 111 Dallas St. Estimated cost $1,000,000. Phelps & DeWees, Gunther Bldg., are architects.

Wis., Adell—Wieland Dairy Co., 3640 Bway., Chicago, Ill. in the market for power boiler for proposed dairy plant, here. R. A. Sutherland, 703 Commercial Bank Bldg., Fond du Lac, is architect.

Ont., Port Arthur—City plans waterworks improvements, including pumping equipment. Estimated cost $1,000,000. J. Antonisen, City Hall. is city engineer. James, Proctor & Redfern, 36 Toronto St., Toronto, are consulting engineers.

Ont., Toronto—City Council plans installing 1½ m.g. sewage pump at Morley Avenue Sewage Disposal works. Estimated cost $15,000. R. C. Harris, City Hall, is engineer.

Que., Lachine—City is in the market for 2 sewer pumps with electric motors. H. Daoust is secretary and treasurer.

Australia, Melbourne—Victorian Government Railways, will receive bids until December 1, for rotary converter or rectifier, with switching equipment for automatic operation.